DRAFT

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

OFFICE OF OCEAN EXPLORATION

EXPLORE

OCEAN EXPLORATION PROGRAM METADATA GUIDELINES

NOVEMBER 25, 2002

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Ocean Exploration Metadata Guidelines

These metadata guidelines have been prepared for the National Oceanic and Atmospheric Administration (NOAA) Office of Ocean Exploration (OE) by Mitretek Systems. Mitretek is a nonprofit corporation chartered to work in the public interest and is under a directed award contract with NOAA to provide objective, conflict-free advice with emphasis on technology investment decision-making, program management, and budget and strategy formulation. This document is provided in accordance with and fulfillment of the Deliverable #15 requirement in Task 20 of the Mitretek contract with NOAA.

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Section 1

Introduction

The National Oceanic and Atmospheric Administration (NOAA), acting on the national vision set forth in the Report of the President's Panel on Ocean Exploration[1] and recognizing the important role of the Federal Government in achieving this vision, assumed a leadership role in 2001 by establishing the Office of Oceanic Exploration (OE) and implementing a dedicated program for systematically exploring the ocean. In the OE strategy, *ocean exploration* is defined as "the pursuit of discoveries through disciplined, diverse observations and recording of the findings." Ocean exploration is planned and executed to achieve discoveries as an intentional process rather than relying on serendipitous discoveries from conventional oceanographic research programs. A critical component of ocean exploration is the recording of results to facilitate sharing of each new baseline level of knowledge across a broad, multidisciplinary user community. Participants in ocean exploration expeditions and projects of discovery cannot embark on the processes of systematically examining the oceans and inland seas, cataloging discoveries, and documenting findings without the ability to purposefully and methodically manage and share the data generated by these processes. Therefore, a standardized and consistently applied mechanism for describing ocean exploration datasets—metadata—is fundamental to a coherent and effective system for managing and exploiting the data.

Accurate, standardized metadata are mandatory for cataloging, managing, and ensuring the long-term stewardship of associated data. Two factors concerning metadata are of particular importance in achieving standardized processes and the routine compliance of participants in ocean exploration activities: (1) the establishment of clear policy guidance from the program sponsor, and (2) the availability of guidelines for participating scientists, principal investigators, managers, and other ocean exploration partners to ensure that responsibilities and accountability for creating, delivering, and maintaining metadata are clear and consistent.[2] The guidelines contained in this document are designed to support federal mandates governing metadata production and policy guidance discussed in the OE data management strategy[3] and contained in Announcements of Opportunity and award vehicles, such as contracts and grants.

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[1] *Discovering Earth's Final Frontier: A U.S. Strategy for Ocean Exploration.* Report of the President's Panel on Ocean Exploration, University Corporation for Atmospheric Research, October 10, 2000.

[2] Mineart, G.M., and F.C. Klein, *A Data Management Strategy for the Ocean Exploration Program.* Proceedings of the MTS/IEEE Oceans 2002 Conference, Biloxi, MS, October 2002.

[3] Data Management Strategy for the Ocean Exploration Program. National Oceanic and Atmospheric Administration, Office of Ocean Exploration, Mitretek Systems, Inc., April 30, 2002.

1.1 Purpose

This document provides guidelines to ocean exploration participants to help them understand, create, and deliver metadata for geospatial datasets[4] collected during expeditions and projects of discovery sponsored by NOAA and OE. The Federal Government has an obligation to act as a competent steward and executor of public funding. This obligation extends to all data and information derived from the investment of these resources. Effective stewardship and wide public access are especially applicable to data collected during OE expeditions[5] since they advance the baseline level of knowledge across a broad spectrum of disciplines. Standard metadata are essential for effective management of OE data. The guidance in this document is intended to facilitate rather than proscribe those activities necessary to meet the requirements of the applicable metadata standards. It is designed for the benefit of those who have primary roles and responsibilities during the conduct of OE expeditions and projects of discovery. These roles include the research vessel commanding officers (COs); the designated Chief Scientist or co-Chief Scientists for an expedition, mission leg, or project; and principal investigators (PIs). PIs are recognized as the primary sources and initial custodians of ocean exploration data.

1.2 Applicability

This document is applicable to all participants in OE expeditions and projects of discovery who are under full or partial sponsorship of the NOAA OE program. It addresses responsibilities and activities of COs, Chief Scientists, and PIs necessary to satisfy the metadata requirements of the Federal Government, the Department of Commerce, NOAA, and OE. Under Executive Order 12906,[6] all federal agencies and other organizations receiving federal funds are required to document geospatially referenced data using the Content Standard for Digital Geospatial Metadata (CSDGM), a national standard under the oversight of the Federal Geographic Data Committee (FGDC). The CSDGM exists to facilitate improved acquisition, distribution, utilization, and public benefit of geospatial data and to maximize the efficiency of investing public resources.

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[4] For the purposes of the OE program, all datasets that include attributes describing geographic reference positions for its data elements are considered “geospatial datasets.”

[5] The terms “expedition” and “cruise” are used as descriptors of the primary method employed for exploring the ocean and collecting ocean exploration data. Typically, an expedition or a cruise is represented by the deployment of a surface-based research vessel along with its supporting sensors, vehicles, tools, and embarked personnel. Ocean exploration data may also be collected through projects of discovery that are not vessel-based. Examples include the use of *in situ* data collection sensors, such as moored sensors and arrays, shore-based sensors and vehicles, and airborne and space-based remote sensors. For the purposes of this document, the terms expedition and cruise are largely interchangeable.

[6] Executive Order 12906, Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure. Federal Register, Vol. 59, No. 71, April 13, 1994, pp. 17671-17674. For more information, see: http://www.fgdc.gov/publications/documents/geninfo/execord.html

Additionally, the Machine-Readable Catalog 21 (MARC 21)[7] and Dublin Core[8] metadata systems represent widely accepted standards for the representation and communication of bibliographic and related information for library holdings. Compliance with the CSDGM for geospatial data provides metadata elements that map to specific elements within these library standards. This document provides participants in the OE program with a minimum set of metadata elements consistent with the MARC 21 and Dublin Core standards for bibliographic documentation of digital video data media. These metadata elements are required to support the NOAA Central Library's emerging video data management capabilities.

1.3 How To Use This Document

COs, Chief Scientists, and PIs participating in OE-sponsored expeditions and projects of discovery will find this document to be of value as a ready reference for guiding metadata generation activities. A copy should be available during field activities to assist critical on-scene metadata creation. PIs should include this document in their personal library as a reference source for continuing metadata maintenance responsibilities. Section 2 of this document provides an overview of metadata, explains its role in facilitating the management of ocean exploration data, and identifies the applicable CSDGM. This section describes four levels or classes of metadata that are widely recognized and are incorporated into the guidance in this document. The remaining three sections of the document provide guidance to COs, Chief Scientists, and PIs to assist them in their metadata responsibilities. This guidance describes specific responsibilities for generating and submitting OE metadata, other associated management and oversight responsibilities, and applicable procedures. It is not intended to supercede other responsibilities assigned in Cruise Instructions or Standard Operating Procedures (SOPs) nor constrain activities unrelated to generating, submitting, and maintaining OE metadata. Table 1-1 provides an overview of metadata responsibilities of COs, Chief Scientists, and PIs, and points to the sections of this document that contain more detailed, related guidance.

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[7] MARC 21 Format for Bibliographic Data. Network Development and MARC Standards Office, Library of Congress, October 2002 (revised). For more information see: http://lcweb.loc.gov/marc/

[8] Dublin Core Metadata Element Set, Version 1.1: Reference Description. The Dublin Core Metadata Initiative, July 2, 1999. For more information see: http://dublincore.org/

Table 1-1. Overview of Responsibilities for Generating and Submitting OE Metadata

Role	Responsibilities	Document Section
Vessel Commanding Officer (CO)	• Facilitate science party access to data and metadata available on the research vessel to support applicable coordination and reporting responsibilities	3
Chief Scientist	• Discuss cruise objectives and availability and format of vessel-based data sources with the CO or designated representative • Convey metadata responsibilities and expectations to the expedition or project science party in advance of the field activity • Collect data supporting Level 1 metadata for the expedition or project • Provide amplifying metadata guidance to PIs as required • Ensure that data supporting Level 1 metadata from vessel-based sources are collected and distributed to the science party as appropriate • Produce a Cruise or Project Report and submit to OE within 90 days of the completion date of the expedition or project	4
Principal Investigator (PI)	• Ensure initial proposal reflects the need for any resources (funding, tools, etc.) required to comply with metadata generation and management responsibilities • Provide an inventory of collected datasets and other Level 1 metadata to the Chief Scientist not later than the conclusion of each expedition or project • Create CSDGM-compliant Level 3 metadata files for each collected geospatial dataset as appropriate • Create digital video catalog metadata for each video data medium • Submit copies of metadata files to OE within 90 days of the completion date of the expedition or project • Maintain and update locally held Level 3 metadata and submit updated metadata file to OE at each major change in data attributes	5

Section 2

Metadata Principles

This section describes the principles underlying the use of metadata to characterize and manage ocean exploration data. The development and management of ocean exploration metadata are based on the following principles:

- Metadata are central to ocean exploration data and information search, discovery, and retrieval functions.
- The ocean exploration metadata structure is based on the CSDGM; this geospatial data standard is mandated under Executive Order 12906 for all federal agencies and organizations receiving federal funds.
- Metadata must conform to the geospatial data standard in order to provide for the proper functioning of ocean exploration data discovery and retrieval operations.
- Data linkages within ocean exploration metadata should link directly to associated datasets, not to supporting web sites that must be subsequently searched again.
- Metadata must be preserved in a secure environment to guard against loss and ensure continuing availability.
- Metadata must be maintained and updated to reflect changes in datasets, data access, or other information necessary to ensure datasets are accurately described in the ocean exploration data catalog.
- The willingness of PIs to generate and maintain compliant metadata has a direct impact on the success of ocean exploration data discovery and retrieval functions, as well as the ultimate utility of the data.[9]

2.1 Definition of Metadata

Metadata consist of information that characterizes data—data about data. Metadata describe the content, quality, condition, and other characteristics of data. Metadata are used to provide documentation for data products and can help a person locate and understand the products. In essence, metadata answer questions concerning who, what, when, where, why, and how for every facet of the ocean exploration data being documented.

Metadata are generally considered to be the information necessary for someone who is not previously acquainted with a dataset to make full and accurate use of that dataset. At a minimum, the metadata associated with a dataset must provide a consistent framework that accomplishes the following objectives:

[9] Individual PI compliance in fulfilling federally mandated metadata requirements is an appropriate performance criterion that may be applied during consideration of subsequent requests for OE or other federal funding.

- Permits assessment of the dataset's applicability to the question or problem at hand
- Supports assessment of the quality and accuracy of the dataset
- Provides all necessary information to permit a user to access and understand the values in a dataset
- Permits the assignment of correct physical units to the values
- Supports the translation of logical concepts and terminology among communities
- Supports the exchange of data stored in differing physical formats and locations

2.2 Role of Metadata in Managing Ocean Exploration Data

Metadata are required to identify and acquire ocean exploration data, determine the data's suitability for meeting specific research objectives, and support timely access to the data over an extended time horizon. Documentation of metadata is vital to a dataset's accessibility and longevity for reuse. Without metadata, potential users of ocean exploration data cannot know what suitable datasets already exist. Additionally, the datasets become obsolete as information about the data is lost with the passage of time and the resultant loss of corporate knowledge. Metadata have several useful roles in managing ocean exploration data.

- *Metadata help support the Federal Government's investment in collecting ocean exploration data in the public interest.* Exploration of the oceans is a critical public investment in our nation's future. Its role in creating and disseminating knowledge can have profound effects on the well being of people and their economies. The Federal Government recognizes the importance of providing access to data acquired using public resources; as such, it has directed federal agencies to support the free flow of information between the government and the public.[10] With passage of time, information about ocean exploration data collected under federal sponsorship can be lost, and the data can lose their associated public value if associated metadata are absent. Subsequent investigators may have little understanding of the content and uses for these data and may find that they cannot trust results generated from these data. Complete and standardized metadata encourage appropriate use of the data.
- *Metadata help facilitate full and open access to ocean exploration data.* Both science and the public are well served by a system of scholarly research and communication with minimal constraints on the availability of data for further analysis. The practice of full and open access to ocean exploration data leads to profound, multidisciplinary discoveries, breakthroughs in scientific understanding and also benefits economic and public policy interests. This full and open access is only possible through the application and management of appropriate metadata standards and practices.

[10]Office of Management and Budget Circular A-130 (Revised), *Management of Federal Information Resources*. Transmittal Memorandum No. 3, Office of Management and Budget, February 8, 1996, Section 7.

- *Metadata promote sharing of ocean exploration data and new discoveries.* Science is a cooperative rather than a competitive enterprise. No individual or institution can collect all of the data needed to address important issues. Few organizations can afford to create all of the data they need. Thus, practices that encourage data sharing in the public domain are necessary to advance science and to achieve resulting societal benefits. By using metadata in appropriate catalogs and clearinghouses, which make data widely accessible and searchable, the Federal Government supports the sharing of information on new discoveries and maximizes the benefit of ocean exploration investment across a broad cross-section of stakeholders.
- *Metadata help ensure long-term stewardship of ocean exploration data.* Ocean exploration commences from an established, baseline level of knowledge about the oceans and incorporates multidisciplinary expeditions and projects of discovery to increase this knowledge. This baseline knowledge results from a complete compilation of past information, including prior oceanographic data collection activities. Metadata are critical for ensuring that data collected today continue to support this baseline knowledge into the future. Good metadata help make sure that tomorrow's oceanographic data collection activities are well planned and do not result in a duplication of data that are already available. These metadata also facilitate effective cataloging and management efforts that help preserve associated data for posterity.

2.3 Metadata Classification Levels

Four levels of metadata have been defined that have applications at various stages of the process of managing ocean exploration data (see Table 2-1). These levels are described in greater detail in the sections that follow.

Table 2-1. Metadata Classification Levels

Classification Level	Description
Level 1	**Basic description** of the field program
Level 2	**Summary report** and data inventory (e.g., Cruise Report)
Level 3	Data **object** and **access information**
Level 4	Formal **publication** of results derived from data

2.3.1 Level 1: Basic Description of the Field Program

Level 1 metadata consist of data that provide a basic description of the field program collecting the data, including location, program dates, data types, collecting institutions, collecting vessel, and participating investigators. Level 1 metadata are represented by a loosely structured compilation of information in free-text format on unspecified media; Level 1 metadata include the following elements, where applicable:

- Expedition title

- Project titles (including sponsor and identifying name/numbers)
- Co-sponsors/partners/participating organizations
- Vessel identification (if applicable)
- Embarked vehicles, sensors, and tools of significance
- Expedition dates
- Identity of Chief Scientist(s) and PI(s)
- Cruise/project objectives
- Itinerary
- Geographic area of operations
- Summary of operations: data/time/posit/ID/operation/dive tracklines/depth/comments
- Milestones achieved (sq. miles surveyed, new species found, depth records set, etc.)
- Sample log summaries
- Summary of digital data collected
- Outreach activities summary

2.3.2 Level 2: Digital Summary Report and Data Inventory (Cruise Report)

Level 2 metadata consist of a summary report and data inventory that is created shortly after completion of the data collection process. For oceanographic applications, this level of metadata typically takes the form of a Cruise Report. A collection of NOAA research programs, Fisheries-Oceanography Coordinated Investigations (FOCI),[11] has adopted a Cruise Report format that is acceptable Level 2 metadata for OE. An example of a completed FOCI Cruise Report is provided in Appendix A. This example provides guidance for the type and detail of Level 2 metadata that should be submitted in conjunction with an OE expedition, supplemented by the elements in Section 2.3.1 as appropriate.

There is significant flexibility in the Level 2 metadata format, as long as the information provided is complete and readable. In the event that the FOCI Cruise Report format is not followed, a similar high-quality report in other formats is acceptable. OE recognizes that many institutions impose their own requirements for cruise reports and anticipates that all such standard reports will be acceptable Level 2 metadata, supplemented by the elements in Section 2.3.1 as appropriate. An example of a satisfactory Cruise Report in a generic format is provided in Appendix B.

2.3.3 Level 3: Data Object and Access Information

Level 3 metadata consist of data object and access information, provided in CSDGM American Standard Code for Information Interchange (ASCII) file format. Level 3 metadata include data formats, quality control, processing, and any elements necessary to describe subsequent changes in the content, format, and accessibility of the companion data. During the lifetime of a dataset, multiple modifications to the Level 3 metadata are possible as its

[11] For more information see: http://www.pmel.noaa.gov/foci/

access information changes and as the dataset is manipulated and combined with other data. Each subsequently derived dataset necessitates its own companion metadata to describe its unique characteristics.

2.3.4 Level 4: Formal Publication of Results

Level 4 metadata describe the formal publication of results derived from the data.[12] The format and content can vary widely and are not specified by OE. The process of developing and disseminating publications that represent Level 4 metadata is beyond the scope of this guidance document.

2.4 Content Standard for Digital Geospatial Metadata

Under Executive Order 12906, all federal agencies and organizations receiving federal funds must document geospatial data, including ocean exploration data, using the CSDGM and supplemental profiles approved by the FGDC. These metadata standards have been adopted by NOAA and continue to be emphasized through active participation with the FGDC in the National Spatial Data Infrastructure (NSDI). The CSDGM specifies the metadata information content for a set of accompanying digital geospatial data. The standard establishes a common set of terminology and definitions for concepts related to metadata, including the names of data elements and compound elements (groups of data elements) to be used, definitions of these compound and data elements, and information about the values that are to be provided for the data elements.

The CSDGM is represented in the following applicable publications available via the FGDC website:[13]

- The Content Standard for Digital Geospatial Metadata (FGDC-STD-001-1998)
- The Content Standard for Digital Geospatial Metadata Part 1: Biological Data Profile (FGDC-STD-001.1-1999)
- The Content Standard for Digital Geospatial Metadata Part 2: Metadata Profile for Shoreline Data (FDGC-STD-001.2-2001)

In addition to these governing documents, the FGDC website provides access to pending profiles and extensions to the standard, such as an emerging extension for remotely sensed data that may be of value to particular data producers.

The standard specifies the elements that are mandatory (must be provided), mandatory if applicable (must be provided if the dataset exhibits the defined characteristics), and optional (provided at the discretion of the producer of the dataset). The standard describes metadata

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[12] Examples of Level 4 metadata include conference presentations, peer-reviewed journal articles, and public lectures.

[13] For more information see: http://www.fgdc.gov/metadata/contstan.html

extensions that may be defined by a data producer for metadata elements that are outside the standard but needed by the producer. The standard specifies information content, but not how to organize this information in a computer system or in a data transfer, or how to transmit, communicate, or present the information to a user. Several reasons exist for this approach:

- There are many means by which metadata could be organized in a computer. These include incorporating data as part of a geographic information system, in a separate data base, and as a text file. Participating organizations are able to select the approach which suits their data management strategy, budget, and other institutional and technical factors.
- There are many standards and formats used to transfer geospatial and related data. Some permit the transfer of metadata, some do not. Decisions about how to accommodate metadata in a transfer must be made by the organizations that establish these transfer standards.
- There are a large number of methods used to transmit, communicate, and present metadata. Different metadata elements will be valued by different users, or by one user for different tasks. The Internet and other technologies are resulting in rapid changes to supporting information technology. Many users continue to need or prefer metadata on physical media, including paper. The standard allows information providers to use the techniques and forms which best meet the diverse needs of their users.

The CSDGM defines a *dataset* as a “collection of related data.” The granularity of data to which the standard should be applied and limitations of how to apply the standard are not specified. Many organizations start to implement the standard for a collection known as a *layer* or *coverage*. Some organizations have a series of layers for which some elements, such as spatial reference and entity, attribute, and distribution information, are the same. These elements are recorded once and inherited by the member layers of the series using parent-child metadata relationships (see Section 5). As long as the mandatory and appropriate mandatory-if-applicable elements are complete and available to data users, the metadata comply with the CSDGM.

The best time to create metadata is while the data are being collected. An increasing delay in creating metadata results in an increased risk of less accurate information being recorded and increased costs caused by additional searching for information. A large number of details can be encoded in metadata; judgment is needed on what information will be useful in the context of the associated dataset. Care should be taken to avoid allowing issues related to legacy data to unduly influence the need to document new data.

Section 3

Metadata Guidance for Commanding Officers

Coordination between the science party and the research vessel crew is important; such coordination ensures that data and metadata collection resources of the vessel are identified and that arrangements are made for the availability of data from these resources to the Chief Scientist and participating PIs. This coordination routinely occurs during the planning phase of an expedition; the results are manifested in the publishing of specific Cruise Instructions. The procedures for science party access to these resources may already be well established in specific research vessel SOPs. The cooperation between the Chief Scientist and the Commanding Officer ensures that ship-source information is available during and soon after the cruise so that the Chief Scientist and other science party personnel can fulfill their metadata production requirements easily and within the required timeframe. The guidance in this section is summarized in Table 3-1.

Table 3-1. Guidance for Commanding Officers

Expedition Phase	Description
Pre-Expedition	• Discuss cruise objectives and types/formats of data available from ship sources with the Chief Scientist • Make science party aware of vessel-based continuous data collection systems and procedures for accessing the data • Provide procedures for accessing information from the ship's log
During Expedition	• Coordinate with Chief Scientist and monitor activities to make sure that appropriate and sufficient data and metadata are being collected by the ship's crew and instruments
Post-Expedition	• Ensure that appropriate data and metadata from vessel sources are made available to the Chief Scientist and other science party personnel prior to their disembarking • Make arrangements for transferring subsets of data and metadata that are unavailable at the time of departure of key science-party personnel

3.1 Pre-Expedition Guidance

Before the cruise begins, the CO or his/her designated representative can expect to discuss the cruise objectives and the types and formats of data available from ship sources with the Chief Scientist. This dialog is likely to occur during the normal course of preparing Cruise Instructions and providing standard pre-embarkation guidance to expedition participants. Such discussion will alert the research vessel to the types of data desired by the science party and will provide the Chief Scientist with an understanding of what data and metadata can be provided by the vessel.

The Chief Scientist—and other science-party personnel as appropriate—should be made aware of any vessel-based continuous data collections systems. Examples include flow-through systems for measuring seawater properties, electronic charting systems, and instruments that record position, time, weather, sea state, and solar insulation. Scientific personnel should be aware of data formats and how to access the data during and after the cruise. Procedures for accessing information from the ship's log, both during and after the expedition, should be explained to the Chief Scientist.

3.2 During the Expedition

The CO or designated representative should coordinate with the Chief Scientist and monitor activities during the expedition to make sure that the appropriate and sufficient data and metadata are being collected by the ship's crew and instruments. Daily situation report preparation, "Plan of the Day" meetings, "hot wash-ups," and other informal dialog between the science party and the vessel crew provide multiple opportunities to achieve the desired level of coordination.

3.3 Post-Expedition Guidance

The CO or designated representative should ensure that appropriate data and metadata from vessel sources are made available to the Chief Scientist and other science-party personnel before they disembark. Circumstances such as multi-leg expeditions may result in certain subsets of these data and metadata being unavailable prior to the departure of key science-party personnel. In such cases, arrangements should be made to affect a transfer of these data and metadata as soon as possible. Timely delivery to the Chief Scientist will support the OE program requirement for Cruise Report submission (Section 4) within 90 days of the conclusion of the expedition. Likewise, PIs will require these data and metadata to ensure CSDGM-compliant Level 3 metadata for their datasets are complete and delivered to OE within 90 days of expedition completion (Section 5).

Section 4

Metadata Guidance for Chief Scientists

As the "manager" of the science program during an OE expedition, the Chief Scientist plays a major role in ensuring that expedition participants are aware of metadata requirements and responsibilities and that appropriate metadata are produced by the science party. The Chief Scientist works to integrate the efforts of PIs and, regardless of parent organization or sponsor, bears primary responsibility for reporting the results of the expedition. Although individual PIs are accountable for submission of CSDGM-compliant Level 3 metadata for the datasets under their cognizance—expectations that are specified in OE program guidance—the oversight of the Chief Scientist during the conduct of OE expeditions can contribute significantly to the level of compliance among participants. For projects of discovery that are executed by a single PI, submission of Level 2 metadata by this PI in the form of a Project Report fulfills the analogous Chief Scientist Level 2 metadata obligation. The guidance in this section is summarized in Table 4-1.

Table 4-1. Guidance for Chief Scientists*

Expedition Phase	Description
Pre-Expedition	• Discuss cruise objectives and availability and format of vessel-based data sources with the CO or designated representative • Explain rationale for metadata and need for compliance to PIs • Describe cruise reporting process to PIs and provide guidance on supporting Level 1 metadata that will be required from them • Establish methods, timing, and format for receipt of Level 1 metadata from PIs • Emphasize PI compliance with the CSDGM for Level 3 metadata
During Expedition	• Monitor PIs and confirm that appropriate attention is being paid to Level 1 metadata collection • Observe metadata production efforts of PIs • Answer metadata questions from participants as they arise • Communicate with vessel crew operating installed continuous data collection systems • Collect or arrange for collection of appropriate Level 1 metadata from PIs prior to the conclusion of their participation
Post-Expedition	• Produce Cruise Report (or Project Report if applicable) • Submit report to OE not later than 90 days following the conclusion of the expedition or project

*This guidance also applies, as appropriate, to lead PIs for independent projects of discovery, including those that are not vessel-based.

4.1 Pre-Expedition Guidance

Communicating metadata expectations of the OE program to participating PIs and coordinating with the research vessel CO represent the principal metadata functions of the Chief Scientist prior to the start of an expedition. Ideally, this communication occurs during the planning stages and in advance of embarkation aboard a vessel or commencement of a project. It is possible that individual PI commitments in advance of an expedition may require that a substantial portion of metadata guidance be delivered by the Chief Scientist to expedition participants upon embarkation. In this case, the Chief Scientist can fulfill pre-expedition steps at the first meeting of the science party.

An initial pre-expedition action of the Chief Scientist should be to discuss cruise objectives and availability and format of vessel-based data sources with the Commanding Officer or his/her designated representative. As discussed in Section 3, these discussions are likely to occur during the preparation of Cruise Instructions and receipt of pre-embarkation guidance from the vessel.

The Chief Scientist should explain the rationale for metadata and the need for compliance with PIs. Using Section 2 of this document and personal experience as guides, the Chief Scientist should convey to the science team the critical value of metadata for ocean exploration data. This may require a greater effort for PIs who are new to research activities in the field or have little experience with producing metadata for geospatial data. The Chief Scientist should describe the cruise reporting process and provide PIs with guidance on information—Level 1 metadata—that will be required from them to support the generation of the Cruise Report (copies of sample logs, summaries of collected datasets, etc.). Preferred methods, timing, and format for receipt of Level 1 metadata necessary for completing the Cruise Report should be established so that PIs are aware of the expectations being placed on them.

The Chief Scientist should also emphasize to PIs the OE requirement to comply with the CSDGM for Level 3 metadata production. The attention of PIs can be directed to common sources of shipboard data for basic metadata such as time, position, and surface seawater properties so that the metadata elements ultimately appearing in the CSDGM-compliant Level 3 metadata produced by PIs is as consistent as possible with other Level 3 metadata from the expedition. It may also be appropriate to emphasize the use of common geospatial units, chart datum, tide corrections, and related reference data.

4.2 During the Expedition

During the expedition, the Chief Scientist can monitor the data collection activities of PIs and confirm that appropriate attention is being paid to collecting fundamental Level 1 metadata to support cruise reporting requirements. The Chief Scientist will also have the opportunity to observe PIs identifying and organizing the elements of Level 3 metadata in parallel with the collection and processing of companion datasets. This process may vary among PIs from the employment of an automated metadata generation tool to the capture of elements in the form of handwritten notes for subsequent, post-expedition production of metadata. In any event, *it is important that the Chief Scientist emphasize to PIs the importance of capturing metadata elements as the data are being collected*.

The Chief Scientist can further support the PIs in their metadata production efforts by offering knowledgeable responses to questions as they arise. Communications should be maintained with appropriate personnel from the vessel to ensure that continuous data collection systems installed on the vessel are in operation and that associated data are available to the science party.

Prior to the conclusion of each PI's participation in an expedition, the Chief Scientist should verify receipt of all Level 1 metadata elements from that PI necessary to support generation of the Cruise Report. Special arrangements for delivery of this information should be made if for some reason the PI is unable to transfer all of the required information prior to disembarking.

4.3 Post-Expedition Guidance

The primary metadata-related responsibilities of the Chief Scientist following an expedition are the generation of Level 2 metadata in the form of a Cruise Report (or Project Report, if applicable) and the submission of this report to OE following the conclusion of the expedition.

4.3.1 Cruise Report Format

OE program policy does not specify a single Cruise Report format. OE recognizes the potential need for Chief Scientists to conform to reporting formats dictated by collaborating sponsors and parent institutions. The FOCI Cruise Report format discussed in Section 2.3.2 is an acceptable standard for OE expeditions; an example of this report is provided in Appendix A. Appendix B presents an example of a generic cruise reporting format that is acceptable for OE expeditions and projects. The report should include all of the applicable Level 1 metadata elements listed in Section 2.3.1 in order to satisfy OE program requirements regardless of the format selected by the Chief Scientist. The report should also recognize NOAA/OE as a sponsor and include appropriate usage disclaimers.

4.3.2 Cruise Report Submission Procedures

Chief Scientists should submit the Cruise Report to OE not later than 90 days following the conclusion of the expedition or project. PIs with responsibility for managing ocean exploration projects that are not vessel-based or are similarly independent inherit this reporting responsibility and should submit a Project Report to OE not later than 90 days following the completion of the project's period of performance.

Reports should be submitted to OE using one of the following methods, listed in priority order:

- **Electronic mail (email) file attachment.** Electronic file copies of Cruise Reports are preferred by OE to facilitate ease of access to the reports using the NOAA Ocean Explorer website, ocean exploration data catalog web portals, and other appropriate electronic means. The preferred file format is the Adobe® portable document format (PDF) because of its ability to represent graphical information in an economical file size. Other suitable file formats are generally acceptable. File sizes larger than 8 megabytes (MB) may require transfer to other media (e.g., compact disc [CD], digital versatile disc [DVD], etc.) for physical transfer. Email attachments should be forwarded to the OE drop box at OEData@noaa.gov.

- **Physical delivery of electronic media.** Cruise or Project Reports on physical media such as CDs or DVDs may be mailed or shipped to OE at the following address:

  Office of Ocean Exploration (OE)
  ATTN: OE Data Manager
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  Silver Spring, MD 20910

- **Hard copy delivery.** Hard copies of Cruise or Project Reports may be forwarded to OE at the above address. A parallel delivery of the report in an electronic format is desired to ensure its incorporation in appropriate, Internet-accessible data catalogs and websites.

Section 5

Metadata Guidance for Principal Investigators

Metadata are the means by which ocean exploration datasets can be accessed by a diverse group of user communities. They hold the searchable information used to determine whether or not the associated dataset satisfies a user's specific needs. Those who collect or produce data are in the best position to provide clear descriptions of these data through their production of associated metadata. Much of the information critical to good metadata—such as dimensions and units, accuracies, error ranges, etc.—is familiar only to the individuals directly involved in collecting or generating the data.

This section provides guidance for each PI involved in the production and delivery of metadata to OE. With accountability for each individual project sponsored or co-sponsored by OE, the PI has responsibility for the production of CSDGM-compliant Level 3 metadata for each dataset collected or produced and for the submission of these metadata to OE. The PI is also responsible for supporting the reporting responsibilities of the Chief Scientist described in Section 4. A PI may delegate the responsibilities provided in this section but remains accountable for the production and submission of accurate and acceptable metadata. The guidance in this section is summarized in Table 5-1.

Table 5-1. Guidance for Principal Investigators

Expedition Phase	Description
Pre-expedition	• Ensure initial proposal reflects the need for any resources (funding, tools, etc.) required to comply with metadata generation and management responsibilities
During Expedition	• Provide an inventory of collected datasets and other Level 1 metadata to the Chief Scientist not later than the conclusion of each expedition or project • Create CSDGM-compliant Level 3 metadata files for each collected geospatial dataset as appropriate • Create digital video catalog metadata for each video data medium (see Appendix E)
Post-expedition	• Submit copies of metadata files to OE within 90 days of the completion date of the expedition or project • Maintain and update locally held metadata and submit updated metadata files to OE at each major change in data attributes • Produce appropriate metadata for each additional derived dataset and submit copies of metadata files to OE

5.1 Pre-Expedition Guidance

In submitting responses to OE Announcements of Opportunity, PIs are expected to identify within their proposals any resources required to support the production of compliant metadata. OE encourages the use of appropriate metadata software tools in order to ensure maximum compliance and to minimize the administrative burden on metadata producers. PIs are encouraged to exploit appropriate metadata production capabilities already resident at their parent institutions. Appendix D provides reference information on a variety of metadata production tools. Although the use of these tools is encouraged, the list in Appendix D should not be considered an endorsement of any particular product or set of products.

5.2 During the Expedition

OE expeditions frequently involve multiple PIs working under the leadership of a Chief Scientist. In these cases, the Chief Scientist has a responsibility to create and submit Level 2 metadata to OE in the form of a Cruise Report, as described in Section 4. PIs have a responsibility to support this effort by providing a data inventory and other supporting Level 1 metadata upon request by the Chief Scientist. Applicable Level 1 metadata elements are listed in Section 2.3.1.

PIs will produce CSDGM-compliant Level 3 metadata for each geospatial dataset under their cognizance as soon as possible after data collection or production. Additional guidance related to the CSDGM is provided later in this section. PIs are encouraged but not required to use automated metadata generation tools to help ensure compliant metadata. Media must ultimately support electronic submission of Level 3 metadata files to OE. Questions concerning metadata creation and submission may be directed to OE at OEData@noaa.gov.

With regard to ***digital video data***, a minimum set of metadata elements that map to MARC 21 and Dublin Core standards are required to support emerging video data management capabilities within NOAA. These elements are consistent with the CSDGM and may be extracted from previously generated Level 3 metadata if appropriate. Appendix E provides guidance on this minimum set of metadata elements. PIs will produce a listing for each digital video dataset collected or produced for forwarding to OE after the expedition or project. The lists may be produced in a text or word processing format of the PI's choice but need to be on a medium that can be forwarded electronically to the OE drop box.

5.3 Post-Expedition Guidance

In accordance with OE policy, PIs are expected to submit CSDGM-compliant Level 3 metadata for each geospatial dataset under their cognizance to OE not later than 90 days following the completion of an expedition or other data collection activity. CSDGM-compliant metadata will be submitted to OE in ASCII format. In addition, the MARC 21–Dublin Core metadata elements for digital video data in Appendix E will be provided to OE within 90 days of the completion of an expedition or applicable video production effort. All metadata files will be submitted electronically to OE at OEData@noaa.gov. Section 5.4 provides further guidance on CSDGM requirements and submission procedures.

To maintain currency of metadata within the OE catalog, updates from PIs are necessary in the event that changes are made to the described dataset or metadata related to the dataset (e.g., point of contact information, uniform resource locator [URL] for data access, etc.). PIs holding datasets collected or produced under OE sponsorship are expected to perform the following functions:

- Update locally held metadata and submit updated metadata files to OE for each major change in data attributes.
- Create additional CSDGM-compliant Level 3 metadata files for each additional derived dataset and submit copies of metadata files to OE.

OE will work with contributors to modify metadata or replace existing metadata with an updated file. In the event that changes to metadata are necessary, PIs should contact OE by email at OEData@noaa.gov.

5.4 Level 3 Metadata Requirements and Submission Procedures

This section provides detailed guidance to PIs to help them meet the Level 3 metadata generation and submission requirements described earlier in this section.

5.4.1 Metadata Standards

As noted in Section 2.4, OE metadata standards for geospatial datasets conform to federal policy and the CSDGM defined and published by the FGDC. If exploration data include biological taxonomy, the CSDGM Biological Data Profile should be employed. This profile incorporates metadata extensions of the widely accepted National Biological Information Infrastructure (NBII). A metadata profile for shoreline datasets is also available. Full documentation and supporting information for these metadata content standards are available at http://www.fgdc.gov/metadata/contstan.html.

The following list of CSDGM elements represent the minimum mandatory set for metadata accompanying ocean exploration data:

Section 1: Identification

1.1 Citation

1.2 Description

1.3 Time Period of Content

1.4 Status

1.5 Spatial Domain

1.6 Keywords (see Section 5.4.3 below)

1.7 Access Constraints

1.8 Use Constraints

Section 7: Metadata Reference Information

7.1 Metadata Date

7.4 Metadata Contact (Contact Information)

7.5 Metadata Standard Name

7.6 Metadata Standard Version

Section 8: Citation Information

Section 9: Time Period Information

Section 10: Contact Information

Other elements of the CSDGM are mandatory if applicable. In particular, Section 2, *Data Quality,* and Section 4, *Spatial Reference,* should be included for quantitative data (numeric data files, video transects, etc.). Section 3, *Spatial Data Organization,* and Section 5, *Entity and Attribute,* should be used for spatial data (maps, geo-referenced images, geographic information system [GIS] files, etc.) as applicable. Section 6, *Distribution,* offers PIs a convenient method of describing use and distribution policies for their data. PIs are encouraged to be as complete as possible with metadata in order to add to its value.

PIs should specifically address the following items in their metadata, if applicable:

- Quality assurance and calibration procedures, with statements that convey the limitations of associated data based on these procedures
- Guidance to potential users that reflects their responsibility for the data's use or misuse in further analyses or comparisons and stipulates that the Federal Government does not assume any liability to users or third parties and that the government will not indemnify users for liability due to any losses resulting from the use of the data
- Citation instructions for potential users

5.4.2 Creating Level 3 Metadata

Metadata can be created through use of software tools or by using a text editor. The text editor or word processor option is used to edit a template document that contains all or most of the possible metadata elements and to add text to those elements that are appropriate. Unnecessary or empty elements should not be used. To repeat an element, copy and paste as many as are needed. ASCII templates are simple to use, require no GIS or other specialized software, and may be cloned for parts of the metadata that are common to several datasets. A major drawback of text templates is the lack of built-in control of the structure. In the process of cutting and pasting text, it is easy to damage the structure of the template and its compliance with the standard. This method is also the most rigorous for the metadata producer.

An ASCII template of the full CSDGM is available in Appendix C and also on-line at http://badger.state.wi.us/agencies/wlib/sco/metatool/template.htm. To assist in evaluating metadata authoring software, Appendix D offers brief reviews of several resources. Whichever method is used to create metadata, the final product should be provided to OE in ASCII text form.

For more useful information about the FGDC, the CSDGM, and creating metadata see http://geology.usgs.gov/tools/metadata/tools/doc/faq.html#1.1.

5.4.3 Keywords

Keywords are very important because they make it possible for someone searching for data to find datasets that meet their search criteria. The NOAA Geospatial Data and Climate Services Group has adopted the National Aeronautic and Space Administration's (NASA's) Global Change Master Directory (GCMD) as an appropriate geospatial data keyword index.[14] The GCMD maintains a dynamic list of thematic and other relevant keywords at http://gcmd.gsfc.nasa.gov/Resources/valids/. In the absence of dedicated NOAA or OE keyword indices, PIs are encouraged to consult and use the GCMD keyword index in selecting keywords for their metadata. PIs retain the flexibility offered by the CSDGM to list "none" as the keyword index and insert their own applicable keywords in those cases where the datasets cannot be sufficiently described by the GCMD (e.g., marine archaeological datasets); however, PIs are encouraged to use the GCMD as a keyword index whenever possible.

5.4.4 Parent/Child Metadata

Some datasets are composed of many similar products that differ from each other only in product date and time, geographic location, or a combination of these elements. For example, a remotely operated vehicle might continuously record video and conductivity-temperature-density (CTD) data. As an expedition progresses, these data are recorded in many different locations and on different dates. For this example, the creation of parent and child metadata would be appropriate.

The parent metadata file is a complete metadata record that describes the collection, its content, geographic extent and overall dates of coverage, as well as other source and distribution information. Each child metadata file contains information specific to each subordinate data product—its geographic location, specific date, and a link to the product being documented.

[14] For more information see http://www.eis.noaa.gov/fgdc/fgdcrules.html

PIs using parent-child relationships in their metadata should include the following items:

- A complete metadata description of the data collection (the parent metadata)
- A file of comma-separated values that make up the child metadata for each product
- A description of the child fields and any other information that may be needed to interpret the metadata

To ensure that the parent and child metadata files are related, the parent filename with "_C" added as a suffix should be used in the associated filenames for child metadata.

PIs may contact OE at OEData@noaa.gov for additional guidance in developing parent-child metadata.

5.4.5 Quality Control

Metadata must be carefully reviewed for compliance with the CSDGM in order for metadata to accurately describe collected data and be useful to the diverse community of OE stakeholders. OE will work with PIs to help ensure delivery of compliant metadata. Software tools can streamline the quality control process. Figure 5-1 provides an illustration of the OE metadata submission and quality control process.

PIs are encouraged to use the CNS (Chew aNd Spit) and MP (Metadata Parser) tools for error checking. MP checks for consistency with the FGDC standards and provides for export of metadata in XML (eXtensible Markup Language), SGML (Standard Generalized Markup Language), and HTML (HyperText Markup Language), if desired. For additional information, see http://www.geology.usgs.gov/tools/metadata.

If software tools are not used for metadata quality control, PIs are encouraged to manually confirm the following basic parameters:

- Does the title describe the data adequately; usually the title should answer the 'what', 'where' and possibly 'when' of the data?
- Is the abstract a good summary description?
- Are keywords included?
- Are the structure and content of metadata fields valid? The MP software can be used for these tests.
- Are data made available online or, if not, are instructions provided for offline access?
- Do URL links lead to browse graphics and/or datasets?

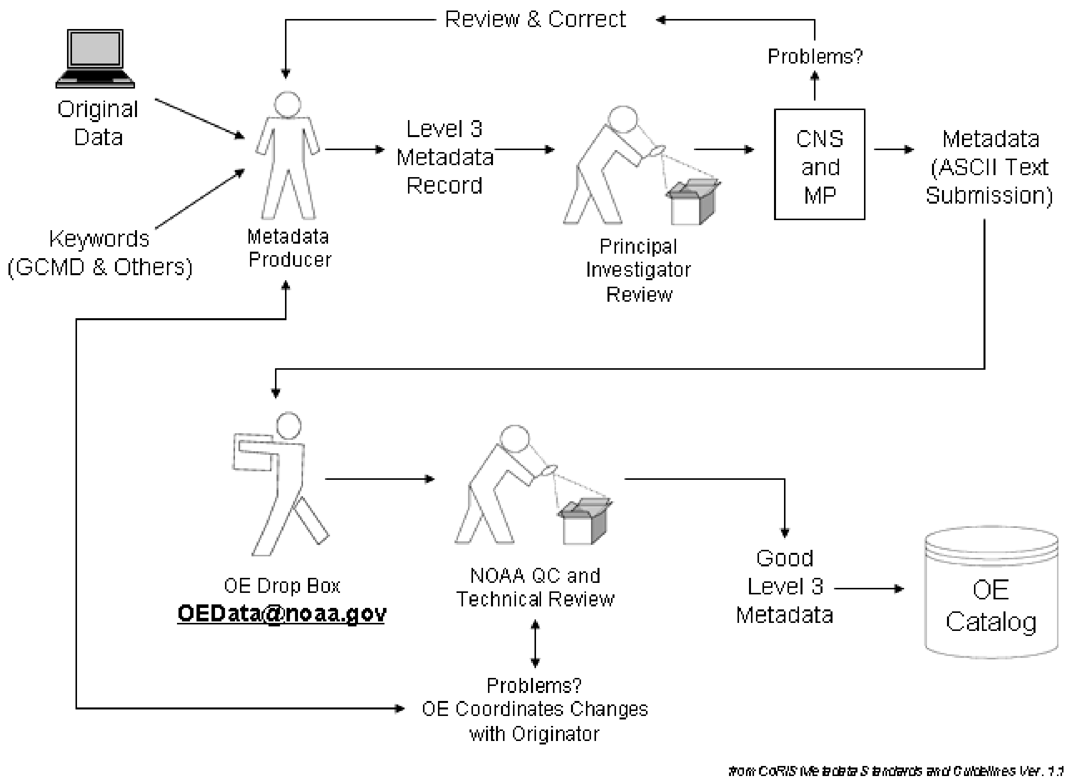

Figure 5-1. OE Metadata Submission and Quality Control Process

Appendix A

Sample FOCI Cruise Report

A collection of NOAA research programs, Fisheries-Oceanography Coordinated Investigations (FOCI), has adopted a Cruise Report format that is acceptable Level 2 metadata for OE. This appendix provides an example of a completed FOCI Cruise Report. The example provides guidance for the type and detail of Level 2 metadata that should be submitted in conjunction with an OE expedition, supplemented by the elements in Section 2.3.1 as appropriate.

CRUISE REPORT

Cruise Number: MF-01-06
FOCI Number: none
Ship: Miller Freeman

Area of Operations: Bering Sea and Aleutian Islands

Itinerary:

Dutch Harbor - May 12, 2001
Dutch Harbor (touch and go) – May 14, 2001
Dutch Harbor – May 22, 2001

Participating Organizations:

NOAA Pacific Marine Environmental Laboratory
University of Alaska Fairbanks

Chief Scientist:

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John Shanley	NOAA/PMEL
Steve Smith	NOAA/PMEL
Sarah Thornton	University of Alaska Fairbanks
David Wisegarver	NOAA/PMEL

Objectives of Cruise:

1. Conduct CTD survey of southeastern Bering Sea basin, slope and shelf
2. Recover and deploy moorings in support of NMFS Crab Research Program, Southeast Bering Sea Carrying Capacity, Pollock Conservation Program, and Steller Sea Lion Research Program

Operations:

CTD casts	31
Bongos, 60 cm	3
Mooring deployments	18
Mooring recoveries	4

Satellite-tracked buoy deployments	4

Samples Collected:

Chlorophyll samples	24
Nutrient samples	72
Plankton samples	3

Summary of Cruise:

The first two days of the cruise (devoted to objective 1: CTD survey) were cancelled because of a storm that kept the ship in Dutch Harbor and the scientific party for that part of the cruise unable to fly to Dutch Harbor from Anchorage. Refer to Table 1, a schedule of operations, and Fig. 1, a map of operations, for summary information about MF-01-06.

Shortly after departing Dutch Harbor at 1400 ADT (2200 GMT) on 14 May, the ship's complement deployed the northern Akutan Pass mooring and conducted a calibration CTD afterward. Because we were unable to locate the current meter for this mooring so soon into the cruise, the hardware and instrumentation (ADCP) for AKP-2, the southern Akutan Pass mooring, were used instead.

After successful interrogation and release the KC-01 crab mooring failed to surface, probably because of excessive marine growth. The ship successfully dragged for the mooring, and it was recovered with only about 90 minutes lost. Figure 2 shows the recovered mooring hardware. The second crab mooring recovery and deployment went smoothly.

We conducted three bongo tows for euphausiids at mooring site 2 and two nearby stations. Diatoms were abundant in the shallowest sample. The subsurface mooring was recovered and a surface mooring (Fig. 3) deployed in its place. Then a second sediment trap mooring was deployed. The shelf was still cold. Surface water ranged from 3 to 4 deg C. The upper layer was about 20-40 m deep. Temperature below was on the order of 2 deg C.

During the night, we conducted a 6-station CTD survey of the 70-m isobath between sites 2 and 4. Water samples for analysis of nutrients and chlorophyll were collected at multiple depths.

At site 4, we recovered the subsurface mooring and deployed a replacement. Then we steamed to Seguam Pass, deploying four Argo floats en route. Early reports from Argo headquarters are that these floats are functioning well. They will sink to the ocean bottom, then rise and report again every ten days. These floats will contribute to a worldwide oceanographic network that will revolutionize the field of physical oceanography in the same way the radiosonde network revolutionized meteorology in the last century.

At Seguam Pass, two moorings were deployed, the second with a nutrient meter.

Due to hardware problems, there was no CTD after deployment of SMP-1.

Four upward looking ADCP moorings were deployed across Unimak Pass. One mooring (AMP-4) sustained minor damage when the syntactic float containing the ADCP (Fig. 4) accidentally struck the ship during deployment. The float was recovered, the ADCP tested, then redeployed. Calibration CTDs completed each mooring operation.

In deploying the Alaska Stream moorings (GS-1 through GS-5), we first located the 1000-m isobath along the survey line using the echo sounder, then deployed GS-1 and completed its CTD. We then surveyed the bottom depth southward along the line. The deepest bottom depth we could discern with the echo sounder was about 5100 m. The deepest mooring was designed for 6000 m. It was decided to modify the deepest mooring for 5100 m and the next deepest mooring for 3500 m instead of its designed depth of 4500 m. This gave better horizontal spacing versus depth. All moorings were deployed successfully, and water conditions were documented by CTD casts.

In the remaining time, we elected to complete the six southernmost CTD stations along the line from mooring site #6 to mooring site #3. This is a significant fraction of the work that was lost to the storm at the beginning of the cruise. Results will permit estimation of the strength of the Aleutian North Slope Current

Our final sea day saw the deployment of the southern Akutan Pass mooring and its accompanying CTD cast.

We feel most fortunate to have accomplished all of the mooring deployments and recoveries during this cruise. Despite the initial poor weather that kept us from completing the CTD survey, the excellent weather after we sailed and the skill of the ship's complement allowed us to complete all the scheduled work and even complete some of that missed early in the cruise. Our thanks go out to the capable men and women of the NOAA Ship *Miller Freeman* under the leadership of Captain Dean Smehil. We especially recognize the effort expended by Chief Boatswain Rick Pietrusiak and the entire deck department who spent many long hours on mooring deployments and recoveries. We thank Chief Survey Technician Greg Kaufmann and all of the bridge watchstanders for their tireless assistance in completing the scientific objectives of this cruise.

Specifics of operations:

2001 Date (GMT)	Time (GMT)	N Latitude (deg min)		W Longitude (deg min)		ID number	Operation	Depth (m)	Comments
05/15	0023	54	04.02	166	17.83	AKP-01-1	Deploy mooring	82.5	mooring 2 (ADCP) deployed in north position in pass

05/15	0043	54	03.77	166	17.07	CTD001	CTD	83.2	At AKP-2
05/15	2222	56	25.09	160	12.80	CTD002	CTD	23.0	At crab mooring 1
05/16	0030	56	24.86	160	13.33	KC-00-1	Recover mooring	23.1	After dragging operation
05/16	0130	56	25.04	160	12.97	KC-01-1	Deploy mooring	23.6	
05/16	0144	56	25.28	160	13.31	CTD003	CTD	24.2	At KC-1
05/16	0421	56	30.03	161	00.18	CTD004	CTD	67.2	At KC-2
05/16	0442	56	29.88	160	59.85	KC-00-2	Recover mooring	66.1	
05/16	0458	56	29.90	160	59.92	KC-01-2	Deploy mooring	66.3	
05/16	0511	56	30.07	161	00.15	CTD005	CTD	66.9	At KC-2
05/16	1345	56	59.54	163	46.96	Bongo01	Bongo	69.8	Station Z
05/16	1508	56	52.65	164	03.07	Bongo02	Bongo	73.3	Site #2
05/16	1531	56	52.94	164	02.83	CTD006	CTD	73.0	
05/16	1634	56	52.19	164	03.98	BS-2	Recover mooring	72.4	Subsurface mooring
05/16	2152	56	52.99	164	03.50	BSM-2	Deploy mooring	72.8	“Peggy”
05/16	2326	56	52.99	164	03.20	BSST-2	Deploy mooring	72.7	Sediment trap
05/16	2348	56	53.20	164	02.98	CTD007	CTD	72.8	Site #2
05/17	0146	56	46.11	164	19.60	Bongo03	Bongo	75.0	Y
05/17	0444	57	06.93	164	60.00	CTD008	CTD	70.3	AA
05/17	0757	57	24.89	165	51.97	CTD009	CTD	68.4	AB
05/17	1056	57	32.15	166	43.86	CTD010	CTD	70.3	AC
05/17	1403	57	37.97	167	36.14	CTD011	CTD	70.9	AD
05/17	1702	57	45.98	168	28.12	CTD012	CTD	71.8	AE
05/17	1837	57	51.33	168	52.16	CTD013	CTD	72.5	Site #4
05/17	1932	57	50.53	168	52.65	BS-4	Recover mooring	72.1	BS-4
05/17	2249	57	51.18	168	52.16	BS-4	Deploy mooring	72.4	BS-4
05/17	2303	57	51.34	168	52.00	CTD014	CTD	72.4	Site #4
05/18	1220	55	29.96	170	30.14	Argo 464	Deploy satellite drifter	3179	Argo float 1
05/18	1608	54	50.10	170	58.05	Argo 470	Deploy satellite drifter	3179	Argo float 2
05/18	1946	54	10.09	171	25.96	Argo 503	Deploy satellite drifter	3279	Argo float 3
05/18	2328	53	30.11	171	54.02	Argo 507	Deploy satellite drifter	2661	Argo float 4
05/19	0637	52	15.98	172	45.04	SM-1	Deploy mooring	159.6	Seguam Pass
05/19	0846	52	08.07	172	25.19	SM-2	Deploy mooring	167.7	

05/19	0905	52	08.29	172	24.88	CTD015	CTD	168.5	
05/19	1119	52	22.91	172	07.05	AMP-4	Deploy mooring	370.0	Amukta Pass, damaged on deployment, sensor OK
05/19	1140	52	23.16	172	06.85	CTD016	CTD	360.7	
05/19	1249	52	24.00	171	55.08	AMP-3	Deploy mooring	308.6	
05/19	1308	52	24.23	171	54.98	CTD017	CTD	307.6	
05/19	1434	52	24.98	171	39.93	AMP-2	Deploy mooring	458.6	
05/19	1500	52	25.24	171	39.81	CTD018	CTD	477.9	
05/19	1607	52	26.00	171	27.04	AMP-1	Deploy mooring	414.0	
05/19	1628	52	26.11	171	26.49	CTD019	CTD	392.9	
05/20	0052	52	23.81	169	44.78	GS-1	Deploy mooring	986.1	Alaska Stream (mooring position and anchor drop position are the same
05/20	0157	52	23.69	169	44.80	CTD020	CTD	1090	
05/20	1257	51	43.11	169	22.38	GS-5	Deploy mooring	5100	Anchor dropped at 51 43.69 N, 169 22.69 W
05/20	1348	51	44.19	169	22.84	CTD021	CTD	4670	
05/20	1825	51	59.00	169	31.00	GS-4	Deploy mooring	3500	Anchor dropped at 51 59.39 N, 169 31.22 W
05/20	2002	51	59.05	169	30.91	CTD022	CTD	3492	
05/21	0300	52	10.78	169	37.05	GS-3	Deploy mooring	3000	Anchor dropped at 52 11,05 N, 169 37.31 W
05/21	0351	52	11.37	169	37.99	CTD023	CTD	2957	
05/21	0608	52	16.05	169	40.12	GS-2	Deploy mooring	2000	Anchor dropped at 52 16.23 N, 169 40.23 W
05/21	0651	52	15.98	169	39.97	CTD024	CTD	2040	
05/21	1433	53	22.19	168	43.88	CTD025	CTD	291	Start 6-3 survey, A
05/21	1537	53	26.21	168	46.00	CTD026	CTD	1085	B, site #6
05/21	1729	53	31.12	168	53.76	CTD027	CTD	1758	C
05/21	1927	53	36.14	169	02.82	CTD028	CTD	1767	D
05/21	2202	53	46.93	169	16.19	CTD029	CTD	1542	E
05/22	0058	54	02.36	169	34.37	CTD030	CTD	1810	F
05/22	1358	53	56.02	165	55.00	AKP-01-2	Deploy mooring	90.7	AKP-2 with RCM-9
05/22	1412	53	56.24	165	54.73	CTD031	CTD	100.0	

Attachments:

Table 1. Schedule of operations
Figure 1. Map of operations
Figure 2. Photograph of recovered hardware from KC-1.
Figure 3. Photograph of surface float of BSM-2.
Figure 4. Photograph of syntactic float with ADCP.

Table 1. Schedule of operations

Operation	Site	North Latitude deg	North Latitude min	West Longitude deg	West Longitude min	Distance nm	Ship Speed kt	Transit Time hr	Water Depth m	CTD Depth m	CTD Time min	Add-On Time min	Arrive (Local) Date / Time	Depart Date / Time	Cum. Time hr	Cum. Time d
Begin	Dutch Harbor	53	54.50	166	30.90									5/14/01 14:00		
Deploy/CTD	AKP-1	54	4.00	166	18.00	12.2	11.0	1.1	83	73	19	85	5/14/01 15:06	5/14/01 16:50	2.8	0.1
CTD/recover	KC-1	56	25.00	160	13.00	251.2	12.0	20.9	25	15	16	190	5/15/01 13:46	5/15/01 17:12	27.2	1.1
Deploy/CTD	KC-1	56	25.00	160	13.00	0.0	11.0	0.0	25	15	16	30	5/15/01 17:12	5/15/01 17:58	28.0	1.2
CTD/recover	KC-2	56	29.90	160	59.90	26.4	11.0	2.4	60	50	18	10	5/15/01 20:22	5/15/01 20:50	30.8	1.3
Deploy/CTD	KC-2	56	29.90	160	59.90	0.0	11.0	0.0	60	50	18	10	5/15/01 20:50	5/15/01 21:18	31.3	1.3
Bongo	Z	56	59.80	163	47.00	96.4	12.0	8.0	65	55	0	30	5/16/01 05:20	5/16/01 05:50	39.8	1.7
Bongo/CTD/recover	BS-2	56	52.90	164	3.50	11.3	11.0	1.0	73	63	19	90	5/16/01 06:52	5/16/01 08:41	42.7	1.8
Deploy	BSM-2	56	52.80	164	3.50	0.1	11.0	0.0	72	0	0	360	5/16/01 08:41	5/16/01 14:41	48.7	2.0
Deploy/CTD	BSST-2	56	52.80	164	3.50	0.0	11.0	0.0	72	62	19	110	5/16/01 14:41	5/16/01 16:50	50.8	2.1
Bongo	Y	56	46.00	164	20.00	11.3	13.0	0.9	70	0	0	15	5/16/01 17:42	5/16/01 17:57	52.0	2.2
CTD	AA	57	7.00	165	0.00	30.3	11.0	2.8	70	60	19	0	5/16/01 20:42	5/16/01 21:01	55.0	2.3
CTD	AB	57	25.00	165	52.00	33.4	11.0	3.0	70	60	19	0	5/17/01 00:03	5/17/01 00:22	58.4	2.4
CTD	AC	57	32.00	166	44.00	28.8	11.0	2.6	70	60	19	0	5/17/01 02:59	5/17/01 03:18	61.3	2.6
CTD	AD	57	38.00	167	37.00	29.0	11.0	2.6	70	60	19	0	5/17/01 05:56	5/17/01 06:15	64.3	2.7
CTD	AE	57	46.00	168	28.00	28.4	11.0	2.6	70	60	19	0	5/17/01 08:50	5/17/01 09:08	67.1	2.8
CTD/recover	AF (BS-4)	57	51.00	168	52.00	13.7	11.0	1.2	72	62	19	100	5/17/01 10:23	5/17/01 12:22	70.4	2.9
Deploy/CTD	BS-4	57	51.00	168	52.00	0.0	11.0	0.0	72	62	19	140	5/17/01 12:22	5/17/01 15:01	73.0	3.0
Deploy float	Argo float 1	55	30.00	170	30.00	150.9	11.4	13.2	3179	0	0	5	5/18/01 04:15	5/18/01 04:20	86.3	3.6
Deploy float	Argo float 2	54	50.00	170	58.00	43.1	11.6	3.7	3179	0	0	5	5/18/01 08:03	5/18/01 08:08	90.1	3.8
Deploy float	Argo float 3	54	10.00	171	26.00	43.2	12.1	3.6	3279	0	0	5	5/18/01 11:42	5/18/01 11:47	93.8	3.9
Deploy float	Argo float 4	53	30.00	171	54.00	43.3	11.9	3.6	2000	0	0	5	5/18/01 15:25	5/18/01 15:30	97.5	4.1
Deploy	SMP-1	52	16.00	172	45.00	80.1	12.0	6.7	160	0	0	60	5/18/01 22:11	5/18/01 23:11	105.2	4.4
Deploy/CTD	SMP-2	52	8.00	172	25.00	14.6	11.0	1.3	100	90	21	13	5/19/01 00:31	5/19/01 01:05	107.1	4.5
Deploy/CTD	AMP-4	52	23.00	172	7.00	18.6	11.0	1.7	400	390	38	16	5/19/01 02:46	5/19/01 03:40	109.7	4.6
Deploy/CTD	AMP-3	52	24.00	171	55.00	7.4	11.0	0.7	400	390	38	10	5/19/01 04:20	5/19/01 05:08	111.1	4.6
Deploy/CTD	AMP-2	52	25.00	171	40.00	9.2	11.0	0.8	400	390	38	22	5/19/01 05:58	5/19/01 06:58	113.0	4.7
Deploy/CTD	AMP-1	52	26.00	171	27.00	8.0	11.0	0.7	400	390	38	22	5/19/01 07:41	5/19/01 08:41	114.7	4.8
Deploy/CTD	GS-1	52	23.81	169	44.78	62.4	10.5	5.9	1000	990	67	150	5/19/01 14:38	5/19/01 18:15	124.3	5.2
Start bottom survey	Ak Stream	52	23.81	169	44.78	0.0	11.5	0.0	1000	0	0	0	5/19/01 18:15	5/19/01 18:15	124.3	5.2
End bottom survey	Ak Stream	51	43.11	169	22.38	43.0	11.5	3.7	6000	0	0	130	5/19/01 21:59	5/20/01 00:09	130.2	5.4
Deploy/CTD	GS-5	51	43.11	169	22.38	0.0	11.0	0.0	5100	1500	92	270	5/20/01 00:09	5/20/01 06:11	136.2	5.7
Deploy/CTD	GS-4	51	59.00	169	31.00	16.8	11.0	1.5	3500	3000	165	300	5/20/01 07:42	5/20/01 15:28	145.5	6.1
Deploy/CTD	GS-3	52	10.78	169	37.05	12.4	11.0	1.1	3000	1500	92	140	5/20/01 16:35	5/20/01 20:27	150.5	6.3
Deploy/CTD	GS-2	52	16.05	169	40.12	5.6	11.0	0.5	2000	1500	92	90	5/20/01 20:57	5/20/01 23:59	154.0	6.4
CTD	A	53	22.00	168	44.00	74.2	11.6	6.4	500	370	37	0	5/21/01 06:23	5/21/01 07:00	161.0	6.7
CTD	B (M6)	53	26.00	168	46.00	4.2	11.5	0.4	1090	1060	70	0	5/21/01 07:22	5/21/01 08:32	162.5	6.8
CTD	C	53	31.00	168	54.00	6.9	11.5	0.6	1793	1500	62	0	5/21/01 09:08	5/21/01 10:10	164.2	6.8
CTD	D	53	36.00	169	3.00	7.3	11.5	0.6	1500	1490	80	0	5/21/01 10:48	5/21/01 12:08	166.1	6.9
CTD	E	53	47.00	169	16.00	13.4	11.5	1.2	1700	1500	80	0	5/21/01 13:18	5/21/01 14:38	168.6	7.0
CTD	F	54	2.00	169	34.00	18.4	11.5	1.6	1800	1500	80	0	5/21/01 16:14	5/21/01 17:34	171.6	7.1
Waypoint	AKP-1	54	4.00	166	18.00	115.1	11.1	10.4	83	0	0	0	5/22/01 03:56	5/22/01 03:56	181.9	7.6
Deploy/CTD	AKP-2	53	56.00	165	55.00	15.7	11.0	1.4	70	60	19	51	5/22/01 05:22	5/22/01 06:32	184.5	7.7
Waypoint	AKP-1	54	4.00	166	18.00	15.7	11.0	1.4	83	0	0	0	5/22/01 07:57	5/22/01 07:57	186.0	7.7
Terminate	Dutch Harbor	53	54.50	166	30.90	12.2	11.0	1.1	0	0	0	0	5/22/01 09:04	5/22/01 09:04	187.1	7.8

Figure 1. Map of operations

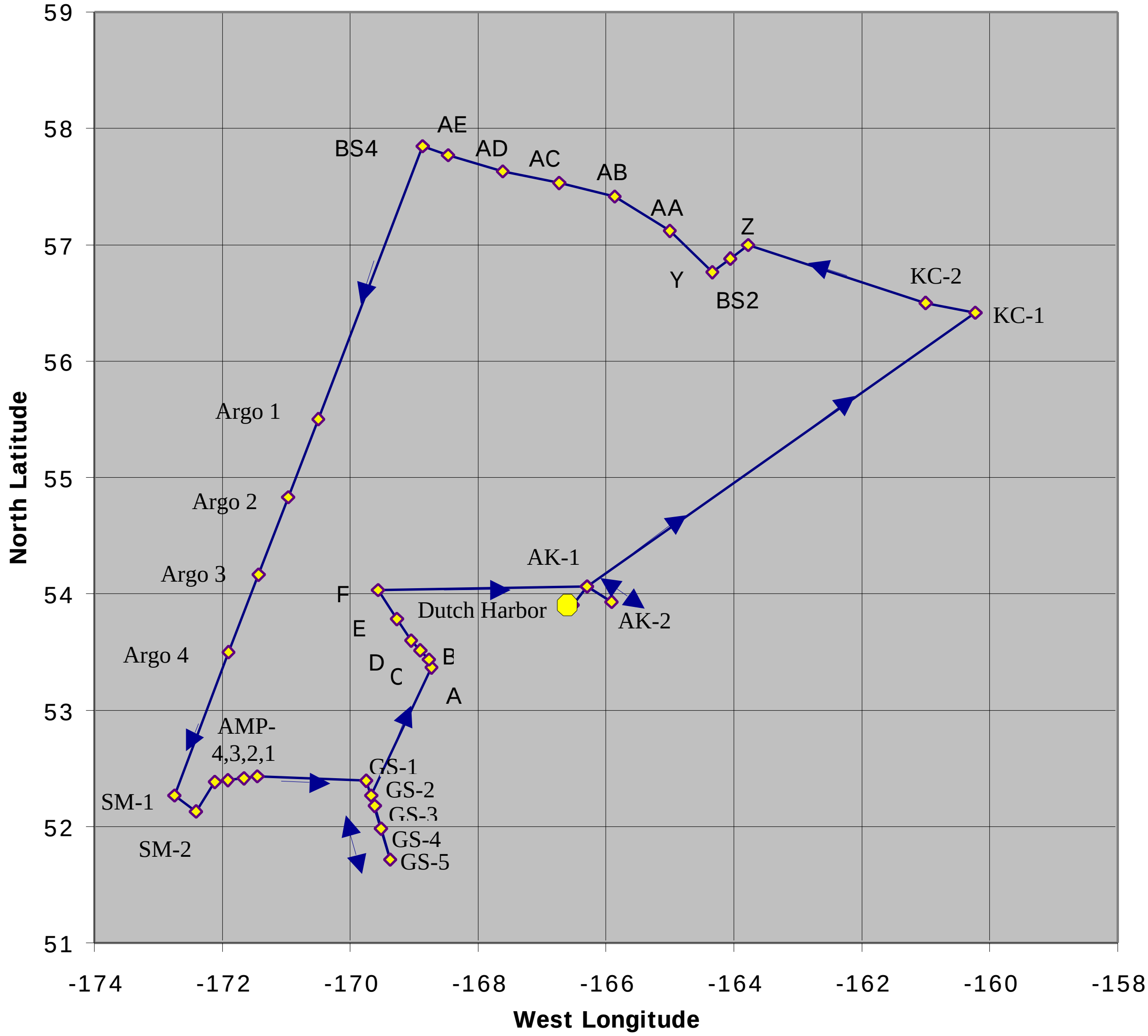

Figure 2. Photograph of recovered hardware from KC-1.

Figure 3. Photograph of surface float of BSM-2 (FOCI-Peggy).

Figure 4. Photograph of syntactic float with ADCP.

Appendix B

Sample Generic Cruise Report

There is significant flexibility in the Level 2 metadata format, as long as the information provided is complete and readable. High-quality reports in other formats similar to the FOCI format are acceptable. OE recognizes that many institutions impose their own requirements for cruise reports and anticipates that all such standard reports will be acceptable Level 2 metadata, supplemented by the elements in Section 2.3.1 as appropriate. This appendix provides an example of a satisfactory Cruise Report in a generic format.

Cruise report for R/V Atlantis Cruises AT-7-15 & AT-7-16
GULF OF ALASKA SEAMOUNT EXPLORATION (GOASEX)

June 22nd – July 15th, 2002
Astoria, Oregon – Kodiak, Alaska – Astoria, Oregon

PRINCIPAL INVESTIGATORS
Dr. Thomas Guilderson, Lawrence Livermore National Laboratory & UC Santa Cruz
Dr. Randall Keller, Oregon State University (Chief Scientist, Leg 2)
Dr. Thomas Shirley, University of Alaska, Fairbanks
Dr. Bradley Stevens, NMFS, Kodiak (Chief Scientist, Leg 1)

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Introduction

Goals of the Expedition

The goals of this Ocean Exploration expedition were to explore five previously unexplored volcanic seamounts in the Gulf of Alaska (GOA) to characterize their unique biota and habitats, and to determine how these undersea mountains formed. The deep-sea submersible Alvin was used at each seamount to collect samples and to develop a photographic inventory of benthic macrofauna during each dive. Comparisons were made between seamounts, and depth transects were conducted with the Alvin to examine depth distribution, habitat utilization and community structure of seamount organisms. A full-coverage swath bathymetry map of each seamount was produced, and various rock exposures were sampled for age, duration, composition, and distribution of volcanic phases, as well as for microbiological studies. Reef-building deep-sea corals and sclerosponges were collected to determine their potential for providing information about climate-ecosystem variability in the GOA, and to determine the distribution and reproductive biology of deep-sea corals. The genetic structure of deep-sea gorgonian corals will be studied to determine whether seamount populations are genetically isolated units. Species distribution and habitat utilization of deep-sea crabs were examined and live samples were collected to determine biological characteristics such as species, sex, and reproductive condition. A 'gentler' manipulator claw was developed and tested on the Alvin to aid in the collection of live crabs. Observations were made at various depth ranges where particular crab species were most abundant, to document reproductive or aggregative behaviors, as well as biological interactions with other species.

Anticipated benefits

Most seamounts in the Gulf of Alaska have never been explored, so there was great potential for new discoveries during this expedition. Because of their isolation, seamounts are known for high levels of endemism. Not surprisingly, a large percentage of seamount fauna has been found to be endemic in other regions of the world's oceans. We anticipated that the GOA seamounts will prove to be as biologically rich as others, and so ultimately the results of this expedition would have profound implications to aid in the protection of seamount fauna in the GOA. Other benefits of this expedition included gaining a more complete understanding of the geologic history of the GOA, and potentially adding to our current knowledge of historic climate and oceanic conditions of this dynamic region. Through our work we will also determine the importance of seamounts as essential habitats for unique and likely endemic species.

Education and Outreach

This expedition provided a wonderful educational opportunity to inform and excite the general public, as well as the scientific community, about unique and unexplored regions of the deep ocean environment. Outreach and education products included detailed lesson plans that target grades 5-12. Undergraduate and graduate students participated in the cruise, and will also benefit through post-cruise presentations by cruise participants at their respective institutions. An Alaskan native undergraduate student from the University of Alaska participated in the cruise, as did a K-12 educator. The student and teacher assisted with the collection of material for the NOAA oceanexplorer.noaa.gov website, through which the general public was targeted. A team of professional videographers were present on the northbound leg of the cruise with the goal of developing an expedition video that will target a general audience.

A scheduled port stop in Kodiak, AK, provided an opportunity for invited students, teachers, fishing and conservation representatives, elected officials, and other invited guests to come aboard the RV Atlantis and view Alvin and the science made possible by this expedition.

GOALS AND OBJECTIVES OF EACH RESEARCH TEAM

Geology and Microbiology

Our goal is to understand the volcanic and tectonic histories of seamounts in the Gulf of Alaska, and thus expand our knowledge of the geologic history of the Gulf. In order to understand how the Gulf of Alaska seamounts formed and for how long they were volcanically active, we planned to visit five previously unexplored seamounts (Figure 1), create full-coverage swath bathymetry maps of them and their surroundings, and collect rock samples to determine their volcanic histories. In addition to the importance of these seamounts as geologic records of volcanic activity in the Gulf of Alaska and the dynamics and kinematics of the Northeast Pacific Basin, they are significant for their influence on oceanographic circulation, and also serve as centers of biological activity. Our explorations also included a search for new microorganisms living in the rocks. The frontiers of microbial research are expanding rapidly, largely as a result of the search for microorganisms with medical and industrial applications.

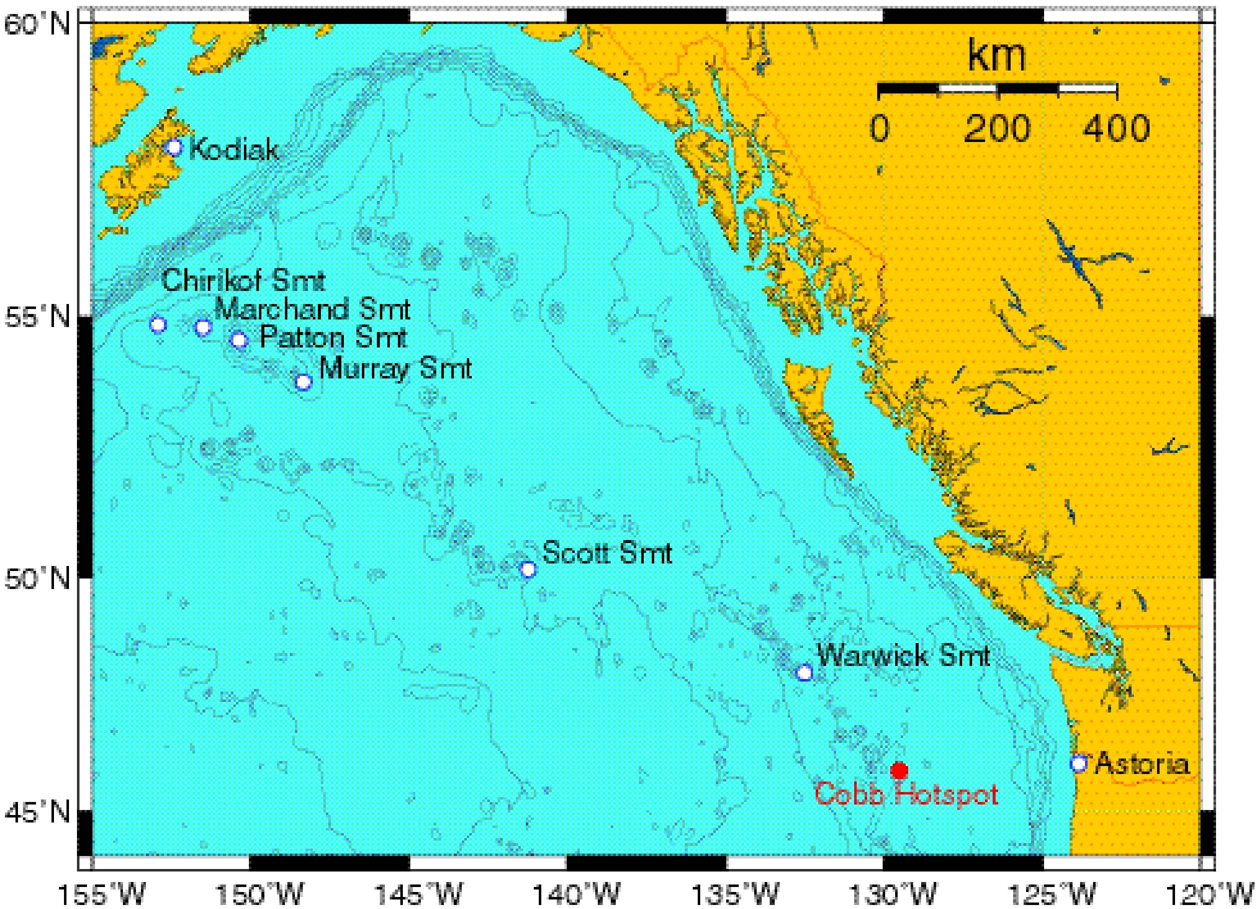

Figure 1. Map of the Gulf of Alaska showing the locations of the six seamounts visited on this expedition. Scott Seamount was mapped, but not sampled. The current location of the Cobb hotspot under Axial Seamount on the Juan de Fuca Ridge is also shown because all of these seamounts (except for Scott) probably formed at the Cobb hotspot.

Our approach was to create a full-coverage swath bathymetry map of each seamount and collect rock samples along vertical transects through the maximum possible depth intervals, with the objectives to establish the:

• Volcanic history of Murray Seamount. Are there undiscovered rift zones or summit cones on Murray that are the source of the anomalously young basalts known to exist nearby?

• Volcanic history of Warwick Seamount. This seamount formed above a hotspot, but close to a spreading center. How does its volcanic history reflect the interplay of the hotspot and the ridge, especially in comparison to the younger and older seamounts in the same hotspot trail?
• Age and plate tectonic setting of Chirikof and Marchand seamounts. What are the ages and origins of these two seamounts? Are they the oldest remaining products of the Cobb hotspot, or do they have some other origin?
• Microbiology of progressively older seamounts in the Cobb hotspot trail. How quickly does microbial alteration of basalts progress, and under what conditions?

Each of these seamounts could stand alone as an exploration target, but the synergy of studying them all together provides comparisons between seamounts formed over the same hotspot but at different times and distances from a seafloor spreading center. In addition, we can extend our comparison to the substantial body of published data from the current location of the Cobb hotspot beneath Axial Seamount on the Juan de Fuca Ridge.

Crabs and Associated Invertebrates

Knowledge of the biology of deepwater crab and other invertebrate species on seamounts is poor, but is essential to obtain before fishing alters them irrevocably. Crab populations at seamount sites are presently under- or unexploited. Our goals in 2002 were to use the information from a previous exploration of Patton Seamount in 1999 to focus on the biology and habitat use of 5 species of deepwater crabs: the golden king crab, *Lithodes aequispinus*, the scarlet king crab, *L. couesi*, the grooved Tanner crab, *Chionoecetes tanneri*, the triangle Tanner crab, *C. angulatus,* and the large-clawed spider crab, *Macroregonia macrochira*. Particular emphasis was placed on the biology of *Lithodes aequispinus* because of its high commercial value and intriguing questions concerning changes in bathymetric distribution with ontogeny.

Our objectives were to visit the depth range in which crabs (particularly juveniles and mature females) are most abundant, document the habitat characteristics by species, sex, and reproductive condition, and observe any reproductive, nocturnal, or aggregative behavior, and biological interactions with other species. Specimens of each crab species were captured to determine their reproductive status. Samples of habitat types, and representative organisms from the surrounding benthic community were collected for examination. This study should provide basic information on biology, ecology, habitat, and behavior for crab species about which little is currently known. An additional objective was to identify other invertebrate and fish species observed on the seamount, and document their depth distribution and community structure. These data could be used for comparison to later surveys on other seamounts; because of their uniqueness, seamounts may be good candidates for Marine Protected Areas.

Specific Objectives and questions:

Adult depth range: Observe and document depth ranges of adult crabs (particularly mature females) principally of *L. aequispina* and *L. couesi*, *C. tanneri* and *C. angulatus*. Determine if males and females occur at similar depth, and if they are segregated by sex.

Habitats and species interactions: Examine and describe the habitats where each species occurs. Determine which species are sympatric and whether they occupy the same habitat.

Juvenile depth range and habitats: Locate juvenile crabs and describe their depth range and habitats/substrates. Collect and examine potential habitats for juveniles, such as: hydroid colonies, coral colonies, and other sessile colonial invertebrates.

Study reproductive condition of female crabs. Capture and examine females in order to determine their stage of larval and ovarian development. Females of some species may be asynchronous spawners, so different crabs may be in different reproductive phases.

Capture and Holding Conditions: Use a “kinder, gentler” manipulator for capturing crabs with less damage. Maintain collected crabs in chilled sea water tanks aboard the *Atlantis.*

Diversity and community structure other species. We hope to compare the invertebrate communities between the seamounts we visit on this cruise. Begin to assemble a picture of the biogeography of GOA Seamounts.

Carbon Cycle and Climate Change

To study changes in ocean circulation and water mass distribution involved in the genesis and evolution decadal climate variability, it is necessary to have records of climate variables several decades in length. Instrumental records are limited because technology for continuous monitoring of ocean currents (*e.g*. satellites and moored arrays) has only recently been available. The historical record of key physical (eg. SST, SLP, salinity) and corresponding environmental (eg. nutrients, phyto-zooplankton standing stocks, fish-catch/recruitment) variables is of insufficient length and contains spatial and temporal gaps such that we have an incomplete picture of the nature of decadal scale variability. Long time-series data is required to test the various hypotheses regarding the ultimate cause of decadal scale variability and increase the reliability of our prognostication of future climate The close correspondence between ecosystems and climate or ocean conditions in the Gulf of Alaska provides a natural laboratory to explore biogeochemical archives in deep-sea corals and sclerosponges in the context of extending our observations back beyond the instrumental record.

Our objectives for this cruise follow this theme with three primary themes: determine the amount of anthropogenic (fossil fuel) CO_2 in the region utilizing Suess effect driven changes in $\delta^{13}C$ and bomb-radiocarbon. Reconstruct the decadal – centennial scale oceanic variability in the Alaskan Gyre via biogeochemical proxy records in deep-sea corals (scleractinian) and gorgonians. Reconstruct the longer or millenial scale (glacial-interglacial) variability as recorded in sediment geochemistry and biological archives (eg. planktonic and benthic foraminifera).

In addition we will assess the longevity of deep-sea corals. Deep-sea macro fauna are not only interesting in their own right but provide habitat for an uncountable number of individuals/species including commercially important species (eg. rockfish, cod, halibut, king crabs). These mini-reefs are threatened by human activities such as trawling and long-lining. There is also a mitigation strategy being developed as part of the national energy policy whereby anthropogenic CO_2 will be directly injected into the deep-ocean (termed ocean carbon sequestration). It is unclear what effect this activity may have on deep-sea ecosystems via alteration of interior water carbon chemistry.

Sampling strategy:

1. Anthropogenic CO_2 in the North Pacific
    a. Underway and CTD stations where we will measure
        i. ΣCO_2
        ii. $\delta^{13}C$, $\Delta^{14}C$ of dissolved inorganic carbon
2. Nutrient cycling and oceanic biogeochemistry
    a. Underway and CTD stations where we will measure
        i. $\delta^{13}C$ and $\delta^{15}N$ of particulate organic carbon
    b. Collection of push cores with sediment/water interface intact.
3. Collection of deep-sea corals: stony (scleractinian) and gorgonians
    a. Distribution of deep-sea corals and relation to depth, T, S, $[O_2]$
    b. Distribution of deep-sea corals in the North Pacific
4. Gravity coring
    a. Bathymetric mapping and sub-bottom profiling of a number of potential targets in the time available.
    b. Collection of giant gravity cores from suitable locations.

RESULTS

Navigation

Atlantis cruise 7-15 departed Astoria, Oregon at 0800 on June 22nd, 2002, and ended in Kodiak, Alaska at 0900 on July 3rd, 2002. Atlantis cruise 7-16 departed Kodiak, Alaska at 0930 on July 4th, 2002, and ended in Astoria, Oregon at 1300 on July 15th, 2002. The first 4 days of the northbound leg were spent in transit to Murray Seamount. We arrived on site in the early hours of June 26th, and conducted a short SeaBeam survey before the first dive on the morning of the 26th. The work pattern thereafter consisted of Alvin dives during the day and SeaBeam surveys, CTDs, and gravity coring at night. Six additional dives were conducted on Murray, Patton, and Chirikof seamounts, before departing the study area at 1700 on July 2nd for the transit to Kodiak. After an overnight transit from Kodiak to Marchand Seamount we conducted the first dive of the southbound leg on Marchand, followed by an overnight transit to and dive on Murray Seamount. We then departed Murray on July 6th for the 30 hour transit to Campbell and Scott seamounts. After passing over Campbell and Scott and determining that the top of Scott was shallower we prepared to dive on Scott, but 20 knot winds and a building swell caused the dive to be postponed and then canceled. We decided to abandon Scott because the top was about 1000m deep and spend the last four dives on Warwick Seamount, whose top comes up to about 500m. After another 30 hour transit, we arrived at Warwick and commenced SeaBeaming, Alvin diving, CTDing, and gravity coring until we departed for Astoria at 2300 on July 13th.

Acoustic Surveys

We conducted complete SeaBeam surveys of each seamount and its surroundings to select dive and gravity core locations and to search for structural and tectonic lineations that could provide clues to how these mountains formed. We obtained full-coverage bathymetry maps of all of the seamounts visited except for Patton, where a map already existed from our 1999 Atlantis cruise.

Dives

On the northbound leg (AT-7-15), seven dives were completed (Table 1), with no dives lost to weather. After the first three dives on Murray Seamount, we determined that the top was too deep to meet our goals of observing Golden king crabs, so the next three dives were made on Patton Seamount. This caused incomplete sampling of geology and coral on Murray seamount, but another dive was scheduled there for the second leg. The final dive of the first leg was on Chirikof Seamount.

On the southbound leg (AT-7-16), six dives on three seamounts included a dive on Marchand Seamount, followed by our fourth dive on Murray Seamount. A dive scheduled for Scott Seamount was canceled due to weather. The final four dives were on Warwick Seamount.

Geology and Microbiology

Geologists participated in 8 of the dives, and at least one good rock samples was recovered on all of the dives except for the 3 on Patton (Table 2), where there is already a good collection of rocks from the 1999 Alvin dives there. Glacial erratics and manganese crusts were a problem on all of the seamounts except Warwick.

Rocks were collected on five dives for microbiological studies (Table 3). The Alvin manipulator placed the rocks in an isolation box which is designed to minimize contamination of the rocks with surface water and to hold the rocks in their ambient sea water until they are transferred to sterile containers on deck. Microorganisms were filtered from the water in the isolation box to collect microorganisms for a control.

Rocks were subsampled and processed in a clean hood in the Atlantis Biology Lab. Subsamples were frozen at -80°C for later extraction of DNA. Whole rock subsamples were preserved for examination by scanning electron microscope (SEM) and for attached prokaryotic abundance (APA). Crushed subsamples were used to inoculate cultures that contained sterile basalt glass, and crushed material was also preserved to determine detached prokaryotic abundance (DPA). These analyses will be completed at laboratories at Oregon State University. Analyses of phospholipid fatty acids (PFLA) will be conducted at a lab in Denmark.

These future analyses will tell us the amount and kinds of bacteria that live within deep sea volcanic rocks. Microbes in these deep sea rocky environments may be some of the most primitive on Earth because of their potential ability to survive on a diet of rocks and water. Microbes with this ability could have lived before the appearance of plants about 3,800 million years ago.

Table 1. Dive Summary

Date	Dive	Location	Latitude (N)	Longitude (W)	Dive Time	Bottom Time	Start Depth	Objectives	Port Scientist	Starboard Scientist
6/22/02		Depart Astoria						Safety drill, science mtg		
6/23/02		In transit						Alvin briefings		
6/24/02		In transit								
6/25/02		In transit								
6/26/02	3797	Murray Smt	53° 53.47'	148° 30.66'	8:29	4:19	2763	rocks & crabs	Keller	Stevens
6/27/02	3798	Murray Smt	53° 53.56'	148° 31.93'	6:44	5:45	1089	crabs & rocks	Shirley	Rowe
6/28/02	3799	Murray Smt	53° 59.54'	148° 30.23'	5:56	4:48	1358	coral & crabs	Guilderson	Nielsen
6/29/02	3800	Patton Smt	54° 36.0'	150° 26.54'	5:42	5:17	485	crabs & coral	Shirley	Roark
6/30/02	3801	Patton Smt	54° 33.94'	150° 23.03'	7:17	6:25	1035	crabs & PR	Stevens	Cohen
7/1/02	3802	Patton Smt	54° 31.83'	150° 18.21'	5:51	3:51	2052	crabs & PIT	Heyl	Berry (PIT)
7/2/02	3803	Chirikof Smt	54° 49.51'	152° 55.73'	8:38	5.23	3222	rocks & coral	Keller	Baco
7/3/02		Arrive Kodiak						Port Call and PR/Outreach		
7/4/02		Depart Kodiak						Transit to Marchand Smt		
7/5/02	3804	Marchand Smt	54° 56.83'	151° 19.19'	8:38	5:29	3038	rocks & coral	Rowe	Flood Page
7/6/02	3805	Murray Smt	57° 1.19'	148° 31.05'	6:28	4:27	1993	coral & rocks	Moy	Fisk
7/7/02		Transit								
7/8/02		Scott Smt	Dive canceled due to rough seas							
7/9/02		Transit								
7/10/02	3806	Warwick Smt	48° 5.35'	132° 50.63'	5:58	4:52	842	coral & crabs	Dunbar	Hoyt
7/11/02	3807	Warwick Smt	48° 4.89'	132° 39.46'	6:54	4:24	2573	rocks & PIT	Fisk	Leach (PIT)
7/12/02	3808	Warwick Smt	48° 3.32'	132° 44.62'	6:37	5:52	758	coral & rocks	Guilderson	Russo
7/13/02	3809	Warwick Smt	48° 5.47'	132° 44.78'	5:12	4:02	1191	coral & rocks	Roark	Russo
7/14/02		Transit								
7/15/02		Arrive Astoria								

Table 2. Rock Recovery

Dive	Seamount	Rocks	Mass (kg)	Lithologies
3797	Murray	8	45	4 basalts, 1 breccia, 1 Mn crust, 2 erratics
3798	Murray	3	14	all breccias
3799	Murray	4	3	1 breccia, 3 erratics
3800	Patton	0		
3801	Patton	1	4	Mn crust
3802	Patton	0		
3803	Chirikof	9	18	7 basalts, 1 hyaloclastite, 1 erratic
3804	Marchand	7	21	5 basalts, 1 breccia, 1 Mn crust
3805	Murray	7	16	6 basalts, 1 erratic
3806	Warwick	1	7	basalt
3807	Warwick	10	44	8 basalts, 2 hyaloclastites
3808	Warwick	5	30	all basalts
3809	Warwick	4	40	all basalts

All samples are curated at COAS, Oregon State University

Table 3. Rock Samples for Microbiology Studies

Sample	Description	Depth (m)	Latitude (N)	Longitude (W)	Samples prepared Cultures	SEM	DNA	APA	DPA	Other
3803-3	hyaloclastite	3170	54° 49.48'	152° 55.67'						Frozen for later study
3804-5	basalt	2459	54° 56.34'	151° 19.48'	yes	yes	yes	yes	yes	DNA of bottom water
3805-1	water	1985	54° 1.18'	148° 30.15'	yes				yes	DNA of bottom water
3806-1	basalt	815	48° 5.41'	132° 50.42'	yes	yes	yes	yes	yes	DNA of bottom water
3807-1	hyaloclastite	2468	48° 4.90'	132° 39.58'	no	yes	yes	yes	yes	DNA of bottom water
3807-2	hyaloclastite	2288	48° 4.81'	132° 39.87'	yes			yes	yes	DNA of bottom water
3807-5	basalt	2028	48° 4.67'	132° 40.24'	yes	yes	yes	yes	yes	refrigerated samples for PFLA
3809-3	basalt	1148	48° 5.25'	132° 44.86'	yes	yes	yes	yes	yes	DNA of bottom water

Crabs and Associated Invertebrates

A total of 67 crab specimens belonging to 9 species were collected from five seamounts. Morphological measurements, carapace condition, and correlates of reproductive status were recorded for these specimens (Table 4). Gonads and embryos were collected when available from female specimens; photo documentation of gonad color and development was made. Many specimens were returned alive to the NMFS laboratory at the end of leg AT-7-15 for culturing and continued studies of their biology. Additional specimens were returned frozen or preserved from cruise leg AT-7-16. For all specimens not retained alive, tissue samples were collected for Dr. Amy Baco (WHOI) for genetic analyses. Additional tissue samples were collected for determination of nutritional sources by means of carbon isotope analyses, to be conducted by Dr. Sathy Nadiu, University of Alaska Fairbanks.

Determinations of depth distributions and habitat associations of adult crabs (principally of *M. macrochira, L. aequispinus* and *L. couesi*, *C. tanneri* and *C. angulatus*) will be made from video tapes collected from the 13 Alvin dives. Most species had heterogeneous distributions, either bathymetrically or spatially; habitat types and faunal assemblages appeared to be involved with the distributional patterns of crab species. Our preliminary observations suggest that juveniles of *L. aequispinus* and *L. couesi* were confined to a narrow bathymetric range at depths deeper than those in which the adults are normally encountered. *Macroregonia macrochira* were ubiquitous at all deeper dive sites (e.g., >1000 m). A significant portion of *M. macrochira* specimens observed in situ were missing appendages, suggesting evidence of predation or agonistic interactions. The lack of regenerating appendages among specimens suggested molting of adults did not occur or was infrequent. Mating or fighting scars were present on the appendages of adult male specimens; one large male was recorded eating an adult female. Feeding or attempting feeding activities of many specimens was recorded on video. Commensal amphipods were collected from two specimens, at depths deeper than previously recorded.

The top of Murray seamount lies at approximately 700 meters depth. *L. couesi, M. macrochira, C. angulatus, Chirostylus sp., Paralomis verillii,* and *P. multispina* were collected there, but no *L. aequispina* were observed (see Table 1). For this reason, we moved to Patton Seamount for the next dives. There, all the above species, plus *L. aequispina, Oregonia bifurca, Munida sp.,* and *C. tanneri*, were observed and/or captured. Of these species, all except for *Munida sp.* had been captured on Patton Seamount in 1999.

Our major goal was to locate and describe the habitat of juvenile of La (see Table 5 for abbreviations) and Lc. This did not become apparent until dive 3801 on Patton Seamount. On that dive, we observed that juveniles of Lc occurred from 550 to 900 m, but that La only occurred in a narrow band from 583 to 623 m. Virtually all juvenile lithodes occurred either on solid rock on or cobble and boulders. They were rarely observed on sand/gravel bottom. Yellow crinoids were abundant from 583 m to the top of Patton Seamount (<300 m), and no juvenile La were observed among them in those depth zones.

Table 4. Crab Measurements

ID	Species	Sex	Dive	Meters	CL	CW	PH	PL	Shell	Notes	Repro	Ovary	Sptheca
	M. macrocheira	M	3805	1300	102.3	87.9	13.5	73.4	3	ML5			
	C. tanneri	M	3806		100.9	116.0	30	50.3	4	DL1,DL2, CB			
	C. tanneri	F	3806		76.6	95.3	17.4	28.5	2			orange, full, partly extruded	
	Galatheid	F	3806		41.6	32.6			2	ND	Large yellow eggs		
	Galatheid	F	3806		29.1	19.9			2	ND	Full clutch, sharp, clean, yellow eggs		
	M. macrocheira	M	EL3807	2600	77.9	67.2	11.2	49	2	ND			
1914	M. macrocheira	F	EL3807	2600	93.9	83.3	13.1	32.3	2	caprellids-mandibles not max. eggs washed out?	No eggs?	peach	MT
1960	M. macrocheira	F	EL3807	2600	93	83.4	13.1	38.2	2	ML4, caprellid on carapace	No eggs?	Pale peach	flacid
1909	M. macrocheira	F	EL3807	2600	75.3	68.0	10.5	31.9	3	MR1	No eggs?	Light orange	flacid
	P.multispina	M	3809	950	95	102.0	29.6	45.4	1	ND			
	M. macrocheira	M	3809	1200	122.3	108.1	24.9	150.4	4	ND, mating scars, CB			
	C. tanneri	M	3809	1200	96.7	117.2			4	Lots of scars,CB			
	L. couesi	M	3809	1200	90.8	95.1	17.2	29.4	2	ND			
	L. couesi	M	3809	1200	122.7	132.2	20.4	35.9	3	ND			
	C. tanneri	M	EL3809	1200	118.8	99.0	23.1	50.4	3	chitinoclastic bacteria			

Table 5. Crab species captured on each dive.

	species							
Dive	Ca	Ch	La	Lc	Mm	Pm	Pv	Grand Total
3798		2		3	1			6
3799				3	1	1	1	6
3800			11	2				13
3801			2	1				3
3802	3				19		2	24
3803					1			1
Grand Total	3	2	13	9	22	1	3	53

Abbreviations are: Ca, *C. angulatu;* Ch, *Chirostylus sp;* La, *Lithodes aequispinus*; Lc, *Lithodes couesi;* Mm, *M. macrochira;* Pm, *P. multispina*; Pv, *Paralomis verillii.*

The pattern of zonation that appears is that the largest specimens of La occur on rock pinnacles from 250-400 m. Juveniles apparently settle in the deeper water below 600 m. The presence of dense fields of crinoids between 400 and 600 m probably prevents successful settlement of juvenile king crabs in their depth zone. Crabs probably have to grow to a size at which they are no longer vulnerable to crinoid predation before they can navigate their way back upslope to shallower depths. Lc remain at deeper depths as adults, perhaps due to competition from the much larger La.

Of particular interest to us were the spider crabs, Mm. Their biology is virtually unknown, yet they are fairly abundant below 1000 m, and the only brachyuran at those depths. We captured 22 specimens either with Alvin's manipulators, or using a baited trap on the elevator. Most did not survive the trip to the surface, despite being placed in a tank of chilled seawater. Many females were dissected for examination of ovaries. Ovary conditions varied from undeveloped and unspawned, to partly developed and ovigerous, to well developed. This suggests that spawning is asynchronous in this species. Samples were also provided to Amy Baco (for Tim Shank) for studies of population genetics. This crab species is widespread throughout the North Pacific deep water, so may prove to be an excellent candidate for such research.

We brought two new tools with us. A large basket with plastic fingers worked exceptionally well for holding large crabs on Alvin's science tray, although smaller specimens sometimes washed out or escaped. The "crabulator", a set of metal fingers for the starboard manipulator did not work as well as hoped, but provided experience for future design modifications. We also built a second "trap" that was placed on the elevator, and was used successfully to capture spider crabs.

Observations of crabs and other invertebrates were recorded on videotape. Some species were not present on both Patton and Murray seamounts. This may be partly the result of depth differences, but some species (eg. The mushroom coral, Anthomastis) were absent even at similar depth zones. Occasional observations of other species were intriguing. During one dive, Alvin was surrounded by flying squid that zoomed past the sub, and some watched carefully, or followed the movements of Alvin's manipulators as they captured samples. Others were seen lying on the substrate. A detailed examination of the videotapes should provide much more valuable information.

A summary of samples taken for genetic studies by Amy Baco-Taylor is given in Table 6.

Table 6. Summary of samples for genetic studies.

	Murray	Patton	Chirikof	Marchand	Warwick
Bamboo spp.	5	11	3		8
Primnoid sp. 1 "white pipe cleaner"	3	3	1		
Primnoid sp. 2	3		1	6	4
Antipatharian spp.	6	1	1		
Paragorgia	2+1?				1
Rubbery Pink	3				1
Other Corals	2	2	1	1	2
Ophiuroid spp.	48+	76+			30+
Polychaetes	2				
Lithodes couesi	1	1			2
Macroregonia macrocheira	2	4	1		5
Chionocetes tanneri					3

Carbon Cycle and Climate Change

Underway sampling was performed on the outbound leg (Astoria – Kodiak) at approximately every half degree of latitude. CTD stations were determined to provide baseline hydrographic information for relation to the distribution of deep-sea macrofauna, and carbon-chemistry. Particulate organic carbon was collected for all underway samples and a sub-set of Niskin bottles from the CTDs.

In the course of this research cruise we participated in 13 Alvin dives. On the first leg, we collected a small number of individuals. A complete listing of the coral collection can be found in the individual dive plan reports. Key samples include: one small living and two sub-fossil bamboo corals, and a large *Paragorgia* from Murray Seamount. On the second leg, we collected a number of living bamboo corals, and a single large *Paragorgia* from Warwick Seamount. Other small living specimens were collected to understand feeding behavior.

Night operations included swath-mapping (sea-beam) bathymetric surveys. These surveys were used to select a small sub-set of saddles, channels, and perched basins for subsequent sub-bottom profiling and assessment of coring. On the first leg, we obtained one short GGC (giant gravity core) at Murray Seamount. No other suitable sites were found, although a more intensive and detailed survey could prove fruitful. A similar strategy was employed on the second leg and six GGCs were taken at depth on the flanks of Warwick Seamount including two cores in excess of fourteen feet in length.

Education and Outreach

SUMMARY

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Dive plan for	Alvin Dive #		**3797**				
Date	6/26/02		Wednesday				
Time	Start Dive		8:00				
	End Dive		17:00				
Location	Murray Seamount						
		Depth (m)	Lat deg	Lat min	Lon deg	Lon min	
Start Position		2700 m	53	53.63	148	30.38	
End Position		2190 m	53	54.38	148	30.71	
Distance	naut. Mi.		0.785				
	Heading (true)		346				
Personnel	Pilot		Bruce Strickrott				
	Port Observer		Randy Keller	Lead Scientist			
	Stbd Observer		Brad Stevens	Scientist			
Objectives	Exploration, bottom to top if possible						
	Collect rocks in sample basket						
	Look for crab species present						
	Look for coral; collect if possible						
	Other inverts						
	Push cores at deepest point						
	Water sample at deepest point						
Special Equipment	Rock Basket						
	wood Biobox						
	Push cores						
	Niskin bottle (1)						
Samples collected	8 rocks (5 volcanic, 2 erratics, 1 Mn crust)						
	3 sediment cores						
	1 sponge						
	several corals						
Sample data				Zulu	m		
				Time	Depth	X	Y
Sediment core 1	left outside			19:15	2727	5064	6750
Coral 1	white, branched, 2 pieces			19:45	2680		
Sediment core 2,3	left inside, right inside			21:17	2388	5004	7522
coral 2	"pipe cleaner", large			22:24	2254	4776	7957
coral skeleton				23:06	2188	4705	8118

Dive plan for	Alvin Dive #	**3798**				

Date	6/27/02	Thursday	
Time	Start Dive	8:00	
	End Dive	1440 on bottom	1530 on deck
Location	Murray Seamount		

	Depth (m)	Lat deg	Lat min	Lon deg	Lon min
Start Position	1094	53	56.00	148	32.50
End Position	670	53	57.10	148	33.00

Distance	naut. Mi.		
Personnel	Pilot	Phil Forte	
	Port Observer	Tom Shirley	Lead Scientist
	Stbd Observer	Mike Rowe	Scientist

Objectives
- Collect crabs in basket
- Collect rocks in basket
- Collect corals
- Push cores at deepest point
- Water samples at deepest point

Special Equipment
- Crab basket
- "Crabulator fingers"
- Small rock basket
- Coral box
- Push cores
- Niskin bottles (5)

Samples collected		Number	Zulu time	Depth	X	Y
Scarlet king crab	Lithodes couesi	3				
red pinchbug	Chirostylus sp.	2		760		
spider crabs	Macroregonia macrochira	1				
Sediment cores		3	2035	936	2656	12308
Niskin water samples		5	2156	718		
3 rocks (all volcanic)						

Dive plan for	Alvin Dive #		**3799**			
Date	6/28/02	Friday				
Time	Start Dive		8:17			
	End Dive	13:47 on bottom				
Location	Murray Seamount					
		Depth (m)	Lat deg	Lat min	Lon deg	Lon min
Start Position		1407	53	59.58	148	30.48
End Position		649	53	58.83	148	30.48
Personnel	Pilot	Pat Hickey				
	Port Observer	Tom Guilderson				
	Stbd Observer	Julie Nielsen				
Objectives	Main coral collection dive on Murray					
	video archive factors determining crab distribution:					
		substrate, depth, coral cover, etc				
	niskins and pushcores where possible					
	collect crabs					
Special Equipment	Coral/Rock box					
	Push cores					
	Niskin bottles (5)					
Samples collected						
	4 rocks (1 volcanic, 3 erratics)					
Scarlet king crab	Lithodes couesi		3			
	Paralomis verillii		1			
	Paralomis multispina		1			
spider crabs	Macroregonia macrochira		1			
Kamchatka coral	Paragorgia arborea		1			
Bamboo coral			3			
Antipatharian coral		several				
basket stars	Gorgonocephalus sp	dozens				

OBSERVER NOTES:

On bottom 1709h, 1404 m water Z
Large spider crab dead ahead -
Brittle stars everywhere
Large branching coral to port that we overshot as we came in for landing.
In hindsight possibly a bamboo coral and one that we would have loved to have.
2 niskins fired #1 and #2 for N.W.
Spider crab volunteered for pot.

Spotted in X: 4920, Y 18067 - 300 m from orig projected dive location, but flew to approp contour.
First coral specimen in Baco bin #1: 4920 18050 2.4°C
1400m
Rock sample 1404m X: 4916, Y: 18048 turned out to be an erratic
Second specimen for AB bin #4: X: 4931, Y: 17954 2.4°C
Third specimen for AB bin#5: X 4956 17857, 2.4°C 1376m Time stamp: 18:08:29

Two large corals in crab basket: 4964 17731, 2.4°C 1337m
bamboo coral attached to rock, and yellow branching coral
Fourth specimen for AB bin#6 X 4954 Y 17652 1308m Time stamp: 18:31:28

Rocky outcrop/ledge @ 1230m Time stamp: 18:51:32

nominal: 4956, 17491 (18:56 - 19:11)
Sampled coral @ this ledge -
one live coral -black coral (sea fan/fern) into crab basket: additional specimens into Baco bins 7, 8, 9
fired niskins 3&4 for NW
Sub-fossil bamboo - can see where it broke off: 4975 17065 932m Time stamp: 19:52

other small bamboos - polyps fully extended, not worth taking - too small.
Another fossil bamboo into crab pot: 4991 16946 838m Time stamp: 20:21

This one was in situ - standing upright and attached
coral sample: 4988 16887 800m, Time stamp: 20:27

Paragorgia spp all over the place 720 - 680m
Paragorgia "felled" 5015 16774, 722m Time stamp: 20:37

Last niskin 4989 16505 664m Time stamp: 21:35h

Dive plan for	Alvin Dive #		**3800**			
Date	6/29/02	Saturday				
Time	Start Dive		7:55			
	End Dive		13:22			
Location	Patton Seamount					
		Depth (m)	Lat deg	Lat min	Lon deg	Lon min
Start Position		484	54	36.00	150	27.00
End Position		274	54	35.00	150	27.00
Distance	naut. Mi.		1			
Personnel	Pilot	Bruce Strickrott				
	Port Observer	Tom Shirley				
	Stbd Observer	Brendan Roark				
Objectives	Golden king crabs + juvenile					
	Collect corals					
	niskins and pushcores where possible					
Special Equipment	Crab basket					
	Coral/Rock box					
	Push cores					
	Niskin bottles (5)					
	Crabulator					
Samples collected	1 mating pair of Lithodes couesi					
	1 mating pair of Lithodes aequispinus					
	9 additional male Lithodes aequispinus					
	6 samples of soft coral	for Amy Baco				
	5 Niskin bottles					
	1 bamboo coral					
	1 Brisingid starfish					

Dive plan for	Alvin Dive #		**3801**			
Date	6/30/02	Sunday				
Time	Start Dive		8:00			
	End Dive		16:00			
Location	Patton Seamount					
		Depth (m)	Lat deg	Lat min	Lon deg	Lon min
Start Position		1023	54	33.85	150	23.10
End Position		325	54	33.90	150	25.60
Distance	Range		0.85 n. mi.			
	Bearing		270	TRUE		
Personnel	Pilot	Phil				
	Port Observer	Brad Stevens				
	Stbd Observer	Chad Cohen				
Objectives	Golden king crabs and juveniles					
	Collect corals					
	niskins and pushcores where possible					
	Live broadcast from the bottom					
Special Equipment	Crab basket					
	Coral/Rock box					
	Push cores					
	Niskin bottles (5)					
	Crabulator					
Samples collected	L. aequispina	2, grasping				
	L. couesi	1				
	Coral samples	5				
	Water samples	3				
	1 rock (Mn crust)					

Dive plan for	Alvin Dive #		**3802**			
Date	7/1/02	Monday				
Time	Start Dive		8:00			
	End Dive		0:00			
Location	Patton Seamount					
	Depth (m)		Lat deg	Lat min	Lon deg	Lon min
Start Position	2052		54	31.69	150	18.17
End Position	1615					
Distance	Range		0.85 n. mi.			
	Bearing		270	TRUE		
Personnel	Pilot	Pat Hickey				
	Port Observer	Taylor Heyl				
	Stbd Observer	PIT - Anthony Berry				

Objectives
Locate crab elevator
Golden king crabs +
juveniles
Collect mature females if possible
Collect corals
niskins and pushcores where possible
Go deep or go home

Special Equipment
Crab basket
Coral/Rock box
Push cores
Niskin bottles (5)
Crabulator

Collections
Located crab elevator and released to surface with 14 crabs
2 push core samples
2 niskin water samples
6 coral samples
2 Paralomis verillii
22 C ang macroregonia

Dive plan for	Alvin Dive #		**3803**			
Date	7/2/02		Tuesday			
Time	Start Dive		8:00			
	End Dive		17:00			
Location	Chirikof Seamount					
		Depth (m)	Lat deg	Lat min	Lon deg	Lon min
Start Position		3300	54	49.48	152	55.67
End Position		2660	54	50.44	152	55.84
Distance	1.5 km					
Personnel	Pilot	Bruce Strickrott				
	Port Observer	Randy Keller				
	Stbd Observer	Amy Baco				
Objectives	Collect rocks					
	Collect corals					
	niskins and pushcores where possible					
	crabs if seen					
Special Equipment	1 extra long milk crate for corals					
	2 long milk crates for rocks					
	2 small milk crates for rocks					
	Niskin bottles (5)					
	Push cores					
Samples collected	9 rocks (all volcanic)					

Dive plan for	Alvin Dive #	**3804**		
Date	7/5/02	Friday		
Time	Start Dive	8:00		
	End Dive	5:00		
Location	Marchand Seamount			

	Depth (m)	Lat deg	Lat min	Lon deg	Lon min
Start Position	3038				
End Position	2163				

Distance	Range	2.9 km
Personnel	Pilot	Phil Forte
	Port Observer	Michael Rowe
	Stbd Observer	Sarah Flood Page

Objectives
Collect frocs from many depths for geology
Collect 7-8 rocks (preferably pillow basalt margisn) from a single location and put in microbiobox
Collect corals (large for Tom, small for Amy)
Niskins (1 each on landing and takeoff, and 1 at large coral or pushcore location)
Collect crabs and pinchbugs if seen

Special Equipment
1 extra long milk crate for corals (and crabs)
2 long milk crates for rocks
Micorbiobox (trigger tracer syringe after box is closed)
Bacobox
Push cores (3)
Niskin bottles(5)

Collections
7 rocks (6 volcanic, 1 Mn crust)
5 small corals of same species
2 niskin water samples
2 large coral samples (same species)
1 Stalk containing barnacles
~6 samples of basalt for microbiobox

Dive plan for	Alvin Dive #		**3805**			
Date	7/6/02		Saturday			
Time	Start Dive		8:00			
	End Dive		17:00			
Location	Murray Seamount					
		Depth (m)	Lat deg	Lat min	Lon deg	Lon min
Start Position		~1950	54	1.17	148	30.86
End Position		~1100	53	59.64	148	30.86
Distance	2.85km					

Near vertical climb with one small saddle towards the end of the dive.
Would like to move horizontally along contours when samples look promising.

Personnel	Pilot	Pat Hickey
	Port Observer	Chris Moy
	Stbd Observer	Martin Fisk

Objectives
- Collect corals (multiple individuals, the bigger the better, bamboo & corallium, living & dead, see photos in sub)
- Collect rocks from many depths for geology (avoid rocks lying loose on surface)
- Collect 7-8 rocks from a pillow basalt margin at a single location as deep as possible and put in microbiobox
- Pushcores (1 at each sedimented location)
- Niskins (1 each on landing and takeoff, and 1 at large coral or pushcore locations)
- Collect crabs and pinchbugs if seen

Special Eqpt
- Large crate for corals (and crabs)
- 1 large milk crate for rocks
- Microbiobox (open, fill with rocks, close, trigger tracer syringe)
- Push cores (3)
- Niskin bottles (5)

Samples collected
- 7 rocks (5 volcanic, 2 erratic)

Dive plan for	Alvin Dive #		**3806**			
Date	7/10/02		Wednesday	Bottom time		
Time	Start Dive		8:00	8:32:00		
	End Dive		17:00	1:23 PM		
Location	Warwick Seamount					
	expected depth range: <1000 meters					
		Depth (m)	Lat deg	Lat min	Lon deg	Lon min
Start Position		871	47.00889		131.1596	
End Position		803	48.09013		131.1596	
Distance		~1 km	mostly in east-west direction			

Navigation problems; very little distance vertically covered; conclusion: we were going around in circles

Started steep and became flat; position was in question

Personnel	Pilot	Bruce Strickrott
	Port Observer	Rob Dunbar
	Stbd Observer	Zachary Hoyt

Objectives

Collect corals (multiple individuals, the bigger the better, bamboo & corallium, living & dead, see photos in sub)
Visual stratigraphy of crab depth zonation, relation to substrate, habitat, etc.
Collect assorted crabs - tasty ones are preferred
Collect 7-8 rocks from a pillow basalt margin at a single location as deep as possible and put in microbiobox
Collect a few rocks if possible
Collect a small (6-inch) piece of many individuals of the same species of coral
Pushcores (1 at each sedimented location)
Niskins (1 each on landing and takeoff, and 1 at large coral or pushcore locations) - if we come across a thicket of corals multiple bottles at once to get enough POC for analyses

Special Eqpt

Crab basket
Bacobox
Microbiobox (open, fill with rocks, close, trigger tracer syringe)
Small milk crate for rocks
Push cores (3)
Niskin bottles (5)

Samples collected	Crabs:	2 Chionocetes tanneri
		2 Galatheids
	Rocks:	1 for microbiology

	Corals:	4 bamboos (1 sub-fossil)
		2 Paragorgia
		4 Gorgonian fan corals
	Water:	4 Niskins
	Other:	1 transparent cucumber

Observations: Area of dive was dominated by communities of large sponges >1 m in size, large Paragorgia and bamboo corals. Many Galatheids were common on corals both Paragorgia and bamboo. Common smaller white sea-fans (?, primnoid?) were observed as well as large sea anemones (up to 15 cm). Substrate consisted exclusively of basaltic flow material, mostly weathered pillows.

Dive plan for Alvin Dive # **3807**

Date	7/11/02	Thursday
Time	Start Dive	8:00
	End Dive	17:00
Location	Warwick Seamount	

	Depth (m)	Lat deg	Lat min	Lon deg	Lon min
Start Position	2609	48	5.00	132	39.20
End Position	1390	48	4.39	132	41.03
Distance	2.55 km				
Bearing	244°				

Personnel	Pilot	Pat Hickey
	Port Observer	Martin Fisk
	PIT	Brian Leach

Objectives

Locate elevator, close lid, trigger release
Collect 7-8 rocks from a pillow basalt margin at a single location as
deep as possible and put in microbiobox
Collect rocks from many depths for geology
Collect corals (multiple individuals, the bigger the better, bamboo &
corallium, living & dead, see photos in sub)
Visual stratigraphy of crab depth zonation, relation to substrate, habitat, etc.
Collect assorted crabs - tasty ones are preferred
Collect a small (6-inch) piece of many individuals of the same
species of coral
Pushcores (1 at each sedimented location)
Niskins (1 each on landing and takeoff, and 1 at large coral or
pushcore locations) - if we come across a thicket of corals, multiple bottles at
once to get enough POC for analyses

Special Eqpt

1 extra long milk crate for corals (and crabs)
Microbiobox (open, fill with rocks, close, trigger tracer syringe)
2 large and 2 small milk crates for rocks
Push cores (3)
Niskin bottles (5)

Samples collected
Released crab trap.

Rock samples

	Time stamp	X	Y	Zm	Bin#
Sample #1	17:34	25437	18347	2467	6
Sample #2	18:00	25074 ?		2288	5
Sample #3	18:43	24707	17958	2091	4
Sample #4	18:53	24649	17927	2055	1
Sample #5	19:00	24612	17912	2027	Biobox
Sample #6	19:02	24612	17912	2027	2
Sample #7	19:40	24495	17855	1919	3
Sample #8	20:02	24464	17844		10
Sample #9	20:24	24352	17822	1706	7
Sample #10	20:31	24282	17787	1653	12
Portside Niskin: btl #5	16:44				
Second Niskin: btl #4	17:04				
Btls 3,2, &1	20:35				
Push cores	16:45			2575	
same nominal location	17:10			2581	

Dive plan for	Alvin Dive #		**3808**			
Date	7/12/02	Friday				
Time	Start Dive		8:00			
	End Dive		17:00			
Location	Warwick Seamount					
		Depth (m)	Lat deg	Lat min	Lon deg	Lon min
Start Position		~775m	48	3.44	132	44.37
End Position		~550m	48	3.44	132	45.86
Distance	2km					
Bearing	Due West					

A shallow climb up from a flat ledge off Warwick. Can zig-zag along contours to find critters/rocks. Approx. end position - not a race to get to the end position. Can go further if so choose as well.

Personnel	Pilot	Phil Forte
	Port Observer	Tom Guilderson
	PIT	Chris Russo

Objectives
- Collect 7-8 rocks from a pillow basalt margin at a single location as deep as possible and put in microbiobox
- Collect rocks from many depths for geology
- Collect corals (multiple individuals, the bigger the better, bamboo & corallium, living & dead, see photos in sub)
- Visual stratigraphy of crab depth zonation, relation to substrate, habitat, etc.
- Collect assorted crabs - tasty ones are preferred
- Pushcores (1 at each sedimented location)
- Niskins (1 each on landing and takeoff, and 1 at large coral or pushcore locations) - if we come across a thicket of corals, multiple bottles at once to get enough POC for analyses

Special Eqpt
- Crab/coral pot
- Microbiobox (open, fill with rocks, close, trigger tracer syringe)
- 2 milk crates for rocks (large and small)
- Push cores (3)
- Niskin bottles (5)

Samples collected: 5 rocks (all volcanic)

OBSERVER NOTES:

Released to bottom ~1500GMT	200m	1510	6.4C
	630m	1524	4.2C
bottom	15:30	760	

sm bamboo, pipe cleaners, anenomes, sm rubbery pink coral, one smallish rattail and Sebastes (red), several small crabs and pinch bugs
bottom consists of a solid MnO crust with a dusting of sediment

will spl small to mid bamboo just to port - few fronds for ABT and rest into crab-pot
Niskin - first from port (#5) 19471 15576 (via Bruce)
19059 15169 overlay
Sm bamboo #1 16:02 758m 3.8C ABT #9
Nav computer acting stupid…. Why the heck would anybody want to run software on a windows box??
reset 2XX, overlay updated 16:23h
We are 60m due south of target
Climbing ~16:25 slight current from south
sm. Black corals 753m 16:27h to port (where are the brittle stars?)
scattered biology, larger sponges
~743m Tanner crab to portside - saw it too late to stop, also some small scarlets(?)
Current picked up like crazy - or did we loose a weight?
back to bottom ~768m 16:52h
Bamboo #2 17:03 19388 15681 larger, good solid thunk coming out
sm reddish coral in crab pot (w/o rock) 19388 15681
Nice wall w/ lots of bio to 726m
Dike below us 17:30
2-rocks spls into bins # 1&2 forward @ 17:42 19226 15640 725 samples 1 & 2
3-chip pan and zoom
Changed DV-CAM tape ~17:57
Bamboo #3 ~17:57 19210 15689 720
2nd niskin port (#4) ~17:57 19210 15689 720
red sea whippy thing on rock
rubble field 715-690m & current much less (finally!!)
Bamboo #4 19155 15581 705 (1 x 1 m) ABT #10 (aft jar)
It is painful to watch Phil prune this to fit in the crab pot.
Scarlet kings - off to port, medium sized but multiples of them. 18:49h 695m
Rock sample #3 19:09 19038 15573 658 bin #3 (port aft of 4-bin box)
taken from a large outcrop of a highly fractured but massive (~2 m wide) lava flow
less MnO crust and more sediment present at depths above the rubble field (~670 m)
Biogeo box - lava tube- rock sample #4 19020 15573 646
samples aquired from both the interior and margin area of a large lava tube in hopes of biological mediated glass margin
Space check - 2 more rocks, 3 niskins, more coral (19:50 hr, ~1 hr bottom time)
Interesting - no gold coral only small black corals - nothing worth grabbing
Bamboo #5 18979 15577 634 (4C) pieces into ABT bins on starboard, both bins
Last 3-niskins fired here before sampling (3-2-1)
This bamboo is incredible !!! 1.5m x 1.5m superstructure (at least) and 40 cm up from stalk. Lots of p/t and 3-chip
octopus to port 2 foot arm-length (via Phil) 18877 15566 617
All three push cores from this small enclave - nice foram sand !!!!
Final rock sample #5 21:00 18884 15569 617
sample acquired near the margin of another massive lava flow, the interior of the flow is characterized by large columnar jointed basalt (columns ~1m in length and well defined

Dive plan for	Alvin Dive #		**3809**			
Date	7/13/02		Saturday			
Time	Start Dive		8:00			
	End Dive		17:00			
Location	Warwick Seamount					
		Depth (m)	Lat deg	Lat min	Lon deg	Lon min
Start Position		~1300	48	5.51	132	44.81
End Position			48	4.43	132	45.41
Distance	2.1 km					
Bearing	S S/W					

A steep climb from a small ledge at mid-depth.
Release crab-trap elevator
Can go further if so choose as well.

Personnel	Pilot	Bruce Strickrott
	Port Observer	Brendan Roark
	PIT	Chris Russo

Objectives
- Collect 7-8 rocks from a pillow basalt margin at a single location as deep as possible and put in microbiobox
- Collect rocks from many depths for geology
- Collect corals (multiple individuals, the bigger the better, bamboo & corallium, living & dead, see photos in sub)
- Visual stratigraphy of crab depth zonation, relation to substrate, habitat, etc.
- Pushcores (1 at each sedimented location)
- Niskins (1 each on landing and takeoff, and 1 at large coral or pushcore locations) - if we come across a thicket of corals, multiple bottles at once to get enough POC for analyses

Special Eqpt
- Crab/coral pot
- Microbiobox (open, fill with rocks, close, trigger tracer syringe)
- 2 milk crates for rocks (large and small)
- Push cores (3)
- Niskin bottles (5)

OBSERVER NOTES:

Samples collected	time	x	y	depth
released to bottom @ ~15:00 GMT				
on bottom	15:49	19056	19276	1200

visible at bottom are a few scattered small black and "pipe cleaner" corals, some red "spine back" fish
and rattail fish, and a couple of shrimp swimming in the water column
bottom is very flat and covered with a few inches of sediment

began looking for crab trap 16:07

crab trap found	16:19	18950	19404	1210
upon arrival two crabs were spotted in the trap and a couple more were on the ground in the near vicinity of the trap.				
crab trap released acoustically	16:35			
1 crab in the trap				
computer crash and rebooted	16:41			
sediment core taken near trap locale	16:45	18950	19404	
niskin bottle #1 fired				
sedimented area around crab trap has lots of rattail fish spread out a few meters apart				
terrane change	17:02	18853	19104	1194
sediment covered ground ends abruptly at the base of a large outcrop of pillow basalt				
Rock sample #1	17:06	18854	19096	1191
sample taken from a large pillow basalt in the outcrop placed into bin position #1 close-up video of sampling also acquired.				
Rock sample #2	17:14	18865	19099	1184
sample collected from the margin of a weathered out pillow basalt and placed into the crab box				
climbing up from the pillow outcrop we came across some MnO oxide plates before returning to flat sedimented terrane		18860	19051	1169
moving along this sedimented area we reached a second outcropping of pillow basalt				
terrane change		18846	18981	1155
Rock sample #3 (biobox)	17:30	18865	18985	1148
two pieces from a large pillow basalt were collected one placed in the biobox and the other into bin#4				
terrane flattened out again	18:05			1130
more "life" present lots of pinch bugs and sponges along with anemones				
terrane change				1100
flat area ended at the base of another massive pillow basalt outcrop. This outcrop also has a lot of flow toes draped over and in between pillow basalts.				
Crab sampled	18:07	18882	18916	1093
terrane change	18:17	18901	18710	
flat area covered with rubble and lightly sedimented				
computer crash	18:20			
computers reset by Bruce				
terrane change	18:24	18895	18641	1088
another pillow basalt outcrop				
terrane change	18:27	18873	18611	1084
"pavement" like terrane with a moderate slope				
terrane change	18:35	18834	18505	1040
back to pillow basalts				
attempted to sample pillow basalt	18:40	18831	18489	1020
sample could not be obtained on account of strong currents				
terrane change				1012
pillow basalts overlain by more massive flows				
terrane change	18:49	18820	18479	995
back to more pillow basalt currents still strong				

terrane change, back to more massive basalt flows				980
Rock sample #4	18:55	18818	18475	977
large basalt piece removed from near the margin of a basalt flow				
terrane change		18812	18445	973
top of the outcrop was reached and terrane flattened out became "pavement" like and was slightly sedimented.				
terrane change	19:13	18786	18383	963
pavement like terrane becam covered by rubble				
bus tye fuse failure	19:30	18787	18217	935
failure leads to end of dive				
final 4 niskin bottles fired	19:34	18790	18220	935

Appendix C

Basic FGDC Template for Metadata

This template includes the *original set* of FGDC metadata fields, and is provided for those who wish to use specific sections in addition to those required for OE Metadata. For element definitions and domain values, refer to the Content Standard for Digital Geospatial Metadata (CSDGM) http://www.fgdc.gov/standards/documents/standards/metadata/v2_0698.pdf. The CSDGM Workbook (Version 2.0) is a popular FGDC reference providing clear, logical instructions for manual production of compliant metadata. It is available in PDF file format through the following location: http://www.fgdc.gov/metadata/meta_workbook.html. It should be noted that this most recent version of the CSDGM Workbook was published prior to FGDC approval of the Biological and Shoreline Data Profiles (discussed in Section 2.4) and thus does not reflect the additional flexibility provided by these profiles.

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      Ending_Date:
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  Progress:
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    East_Bounding_Coordinate:
    North_Bounding_Coordinate:
    South_Bounding_Coordinate:
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        G-Ring_Latitude:
        G-Ring_Longitude:
      G-Ring:
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    Theme_Keyword:
  Place:
    Place_Keyword_Thesaurus:
    Place_Keyword:
  Stratum:
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      Address_Type:
      Address:
      City:
      State_or_Province:
      Postal_Code:
      Country:
    Contact_Voice_Telephone:
    Contact_TDD/TTY_Telephone:
    Contact_Facsimile_Telephone:
    Contact_Electronic_Mail_Address:
    Hours_of_Service:
    Contact_Instructions:
Browse_Graphic:
  Browse_Graphic_File_Name:
  Browse_Graphic_File_Description:
  Browse_Graphic_File_Type:
Data_Set_Credit:
Security_Information:
  Security_Classification_System:
  Security_Classification:
  Security_Handling_Description:
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  Process_Time:
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        Contact_Person:
        Contact_Organization:
      Contact_Organization_Primary:
        Contact_Organization:
        Contact_Person:
      Contact_Position:
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        Postal_Code:
        Country:
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          Contact_Facsimile_Telephone:
          Contact_Electronic_Mail_Address:
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    Column_Count:
    Vertical_Count:
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      Geographic_Coordinate_Units:
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          Latitude_of_Projection_Origin:
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  Local_Planar_Georeference_Information:
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    Ordinate_Resolution:
  Distance_and_Bearing_Representation:
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      Attribute_Domain_Values:
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          Enumerated_Domain_Value_Definition:
          Enumerated_Domain_Value_Definition_Source:
          Attribute:
        Range_Domain:
          Range_Domain_Minimum:
          Range_Domain_Maximum:
          Attribute_Units_of_Measure:
          Attribute_Measurement_Resolution:
          Attribute:
        Codeset_Domain:
          Codeset_Name:
```

```
          Codeset_Source:
        Unrepresentable_Domain:
      Beginning_Date_of_Attribute_Values:
      Ending_Date_of_Attribute_Values:
      Attribute_Value_Accuracy_Information:
        Attribute_Value_Accuracy:
        Attribute_Value_Accuracy_Explanation:
      Attribute_Measurement_Frequency:
  Overview_Description:
    Entity_and_Attribute_Overview:
    Entity_and_Attribute_Detail_Citation:
Distribution_Information:
  Distributor:
    Contact_Information:
      Contact_Person_Primary:
        Contact_Person:
        Contact_Organization:
      Contact_Organization_Primary:
        Contact_Organization:
        Contact_Person:
      Contact_Position:
      Contact_Address:
        Address_Type:
        Address:
        City:
        State_or_Province:
        Postal_Code:
        Country:
      Contact_Voice_Telephone:
      Contact_TDD/TTY_Telephone:
      Contact_Facsimile_Telephone:
      Contact_Electronic_Mail_Address:
      Hours_of_Service:
      Contact_Instructions:
  Resource_Description:
  Distribution_Liability:
  Standard_Order_Process:
    Non-digital_Form:
    Digital_Form:
      Digital_Transfer_Information:
        Format_Name:
        Format_Version_Number:
        Format_Version_Date:
        Format_Specification:
```

```
      Format_Information_Content:
      File_Decompression_Technique:
      Transfer_Size:
    Digital_Transfer_Option:
      Online_Option:
        Computer_Contact_Information:
          Network_Address:
            Network_Resource_Name:
          Dialup_Instructions:
            Lowest_BPS:
            Highest_BPS:
            Number_DataBits:
            Number_StopBits:
            Parity:
            Compression_Support:
            Dialup_Telephone:
            Dialup_File_Name:
        Access_Instructions:
        Online_Computer_and_Operating_System:
      Offline_Option:
        Offline_Media:
        Recording_Capacity:
          Recording_Density:
          Recording_Density_Units:
        Recording_Format:
        Compatibility_Information:
  Fees:
  Ordering_Instructions:
  Turnaround:
Custom_Order_Process:
Technical_Prerequisites:
Available_Time_Period:
  Time_Period_Information:
    Single_Date/Time:
      Calendar_Date:
      Time_of_Day:
    Multiple_Dates/Times:
      Single_Date/Time:
        Calendar_Date:
        Time_of_Day:
    Range_of_Dates/Times:
      Beginning_Date:
      Beginning_Time:
      Ending_Date:
```

```
        Ending_Time:
Metadata_Reference_Information:
  Metadata_Date:
  Metadata_Review_Date:
  Metadata_Future_Review_Date:
  Metadata_Contact:
    Contact_Information:
      Contact_Person_Primary:
        Contact_Person:
        Contact_Organization:
      Contact_Organization_Primary:
        Contact_Organization:
        Contact_Person:
      Contact_Position:
      Contact_Address:
        Address_Type:
        Address:
        City:
        State_or_Province:
        Postal_Code:
        Country:
      Contact_Voice_Telephone:
      Contact_TDD/TTY_Telephone:
      Contact_Facsimile_Telephone:
      Contact_Electronic_Mail_Address:
      Hours_of_Service:
      Contact_Instructions:
  Metadata_Standard_Name:
  Metadata_Standard_Version:
  Metadata_Time_Convention:
  Metadata_Access_Constraints:
  Metadata_Use_Constraints:
  Metadata_Security_Information:
    Metadata_Security_Classification_System:
    Metadata_Security_Classification:
    Metadata_Security_Handling_Description:
  Metadata_Extensions:
    Online_Linkage:
    Profile_Name:
```

Appendix D

Informal Review of Metadata Software

This informal review of metadata software tools has been extracted from the NOAA Coral Reef Information System (CoRIS) Metadata Standards and Guidelines, Version 1.2.

Information on government software tools such as the Metadata Parser (MP) and Chew and Spit (CNS) applications, as well as the latest versions of these tools, are available at

http://www.geology.usgs.gov/tools/metadata

Other available software packages are listed here for information purposes. This list does not imply endorsement of these products by NOAA, OE, or the Federal Government.

D.1 SMMS (Spatial Metadata Management System)

Availability: Commercial software, see URL at http://www.intergraph.com/gis/smms/

Comments: Powerful commercial package incorporating FGDC/NBII elements, fairly user-intuitive with comfortable interface (matches or exceeds Metamaker in capabilities, reportedly under consideration by the U.S. Department of Interior as a standard package). Note: Ownership of SMMS has recently changed; product is scheduled for updating. Cost may be a limiting factor; not designed to be distributed freely:

Single user license: ~$595
2-9 organizational license: ~$575
10-24 organizational license: ~$500

D.2 Metamaker

Availability: Metamaker is no longer being distributed online**;** see URL at

http://www.umesc.usgs.gov/metamaker/nbiimker.html

Comments: Fully documents all data types; but some elements cumbersome, not user-intuitive, parsers are “fussy.” Exports/saves ASCII files in FGDC/NBII standard format; utilizes CNS and MP parsers to generate clearinghouse-ready files. No new versions planned for development by the U.S. Geological Survey (USGS)/Department of Interior. (Effective program, but can be tedious to use; cumbersome in editing keyword lists, “primitive” export capabilities—exports entire keyword list, cannot export keywords by section). Users are advised to upgrade the incorporated CNS and MP parsers to the latest versions (downloadable from the U.S. Geological Survey website at: http://geology.usgs.gov/tools/metadata/)

Metamaker does not put taxonomic information in the NBII standard structure.

D.3 Metalite 1.7.5

Availability: Free, see URL at http://edcnts11.cr.usgs.gov/metalite/

Comments: Shorter FGDC-compliant metadata system also developed by the USGS; built with minimal FGDC elements. No test version online; download program for review. User-intuitive with a simple interface, with documentation. Multi-lingual (English, Spanish, French, Portuguese). Uses MP to generate clearinghouse-ready metadata as text, HTML, and XML files.

D.4 COMET

Availability: Free, see URL at http://www.chesapeakebay.net/comet/login.cfm

Comments: A condensed, FGDC-compliant online metadata system developed, implemented, and utilized by the Chesapeake Bay Program (incorporates needs of state and federal researchers). A test version is available at this site. This system is NOT for general use, but serves as an example/model of a working FGDC/NBII compliant metadata tool built by an individual organization to provide researchers with the ability to generate metadata through an online interface.

D.5 TKME

Availability: Free, see URL at http://geology.usgs.gov/tools/metadata/tools/doc/tkme.html

Comments: Another FGDC-compliant metadata system also developed by the USGS. No test version online; download program for review. The program is user-intuitive with a simple interface, with documentation. TKME can be used to build a standard metadata record but might not handle the elements for the Biological Profile (i.e. taxonomy).

D.6 MetaStar from Blue Angel Technologies

Availability: Commercial software, see URL at http://www.blueangeltech.com

D.7 M^{3}Cat

Availability: Free from FGDC http://www.fgdc.gov/metadata/toollist/m3cat.html

Comments: The multi-standard and multilingual metadata cataloguing M^{3}Cat is a powerful tool for the creation of geospatial metadata. Users can configure their own metadata fields and customize the interface; and supports FGDC, NBII, GILS and ISO, and translations between standards. M^{3}Cat works in a web environment.

The technical prerequisites to install M^{3}Cat are:

Microsoft Windows NT Server with the IIS 4.0 module (Internet Information Service),
Microsoft Windows NT WorkStation with the PWS module (Peer Web Services) installed.

Appendix E

MARC 21—Dublin Core Metadata Elements for Digital Video Data

I. Type
Digital video type:
1. Direct (e.g., DVD-A, DVD-V, DVD-RAM, Mini-DV, Hi-8, HDTV, etc.)
2. Remote – file type (e.g., mpeg, mov, ram, wmf, swf, etc.)

II. Running Time
1. Hours-minutes-seconds (e.g., 3:26:52, 0:00:30, etc.)

III. Title
1. Title is available on the media (label, container, title screen, accompanying documentation, etc.)
2. Title needs to be supplied by video owner, PI, or metadata creator

IV. Producer/Author Identity
1. Personal name (PI, video creator, etc.)
2. Corporate name (Government agency, institution, vendor, etc.)

V. Date
1. Date of coverage (real-time date the video was taken)
2. Date of issue or publication for direct or remote type

VI. Location
1. Place of publication for direct or remote type (city, state, country)
2. Geographical place or area represented in video data:
    Bounding coordinates (GeoRef info)
    Altitude/Depth
    Geographical name (e.g., Palmyra Atoll, etc.)

VII. Content
1. Annotations:
    Abstracts
    Summary notes
    Existence and number of accompanying annotation files if applicable
2. Subject coverage:
    Disciplines (e.g., physical/biological/chemical oceanography; marine geology/ geomorphology/archaeology; etc.)

Species names (provide scientific and common names; applies only to species of primary thematic emphasis in the video data)

Habitat names (e.g., coral reef, etc.; applies only to habitats of primary thematic emphasis in the video data)

VIII. System Requirements for Access
e.g., Windows Media Player, Quick Time, Real Player, etc.

IX. Downloading Requirements
Size of file and program needed for downloading if applicable

X. Contact Information
1. Location of the original/archival and surrogate copies (NOAA Central Library, Data Center, PI's institution, etc.)
2. Contact name(s), mailing address, telephone, facsimile, e-mail, Web site

XI. Online Data Address
1. Uniform Resource Locator (URL) for video data residing online (clip and/or full video)
2. URL for accompanying documents, annotation files, supporting data, etc.
   -size and format information (e.g., HTML, PDF, etc.)

XII. Video Clip Information (supplementing elements I – XI as appropriate)
1. Video clip type:
   direct (CD-ROM, DVD-ROM, Mini-DV, etc.),
   remote (URL address)
2. Title of the clip
3. Running time
3. Size of file
4. Creator of the clip
5. Software required to run it (if different from above).
6. Date and place the clip was created

Glossary

ASCII	American Standard Code for Information Interchange
CD	compact disc
CNS	Chew aNd Spit
CO	Commanding Officer
CoRIS	Coral Reef Information System
CSDGM	Content Standard for Digital Geospatial Metadata
CTD	conductivity-temperature-density
DVD	digital versatile disc
FGDC	Federal Geographic Data Committee
FOCI	Fisheries-Oceanography Coordinated Investigations
GCMD	Global Change Master Directory (NASA)
GIS	geographic information system
HDTV	High Definition Television
HTML	HyperText Markup Language
MARC 21	Machine-Readable Catalog 21
MB	Megabyte
MP	Metadata Parser
NASA	National Aeronautic and Space Administration
NBII	National Biological Information Infrastructure
NOAA	National Oceanic and Atmospheric Administration
NSDI	National Spatial Data Infrastructure
OE	Office of Ocean Exploration
PDF	portable document format
PI	principal investigator
QC	quality control
SGML	Standard Generalized Markup Language
SOP	standard operating procedure

URL	uniform resource locator
USGS	U.S. Geological Survey
XML	eXtensible Markup Language